## FEBRUARY, 1941.

# GENERAL PHYSICS.

### ATOMIC AND MOLECULAR STRUCTURE.

***155. Optimum dimensions of a Clusius-Dickel isotope separator.** W. KRASNY-ERGEN. *Phys. Rev.*, **58**, *pp.* 1078–1085, *Dec.* 15, 1940.—The problem is: How to choose the dimensions of the apparatus in order to obtain, at the smallest possible cost, a given quantity of isotope mixture, containing 1 isotope in a given concentration. The costs are assumed to consist of the costs of the power expended and the costs of the apparatus, the latter costs being proportional to the surface of the tubes. The question of how to choose the dimensions in order to obtain the output with the min. power expenditure or with the min. surface of the tubes is a special case of the general problem. The problem is solved for a single-stage apparatus in which the concentration of the isotope in question is always small compared with unity. Formulae are given for the distance between the tubes, the mean circumference of the annular space between them and the length of the tubes, as well as for the minimum costs. Similarly, the problem is treated for an ideal multi-stage apparatus. In this case the relative abundance of the isotope in question is not restricted to small values. It is shown that the costs are a minimum if the distance between the tubes has a constant value for all stages, this value being the same as for single-stage operation. The mean circumference, however, is different for different stages. Both in the single- and the multi-stage operation an increase in the pressure reduces the costs somewhat. The production of $C^{13}$ is given as a numerical example. AUTHOR.

**156. Structure of melamine.** I. E. KNAGGS, K. LONSDALE, R. G. WOOD AND G. WILLIAMS. *Proc. Roy. Soc. A*, **177**, *pp.* 140–147, *Dec.* 31, 1940.—Magnetic and X-ray measurements on crystalline melamine, $C_3N_6H_6$, indicate that the molecular formula is of the amide type, based on the cyanuric ring, but that weak hydrogen bridges exist between the $NH_2$ groups of one molecule and the ring nitrogens of others, so that the substance may also tend to behave as an imide. The density is 1·571, the space group $P2_1/a$, and there are 4 molecules in the unit cell. An approximate structure is given. New optical data confirm that this structure is of a layer type, in which respect it is similar to all other cyanuric ring compounds so far examined. AUTHORS.

**157. Apparent sizes of atoms in metallic crystals with special reference to Al and In, and the electronic state of Mg.** W. HUME-ROTHERY AND G. V. RAYNOR. *Proc. Roy. Soc. A*, **177**, *pp.* 28–37, *Dec.* 31, 1940.—The inter-atomic distances in crystals of alloys cannot be accounted for by assigning a fixed atomic radius to each kind of atom, and the causes of this variation are discussed with special references to the Brillouin zone characteristics of different structures. According to the theory of Jones the effect of an overlap across the side of a Brillouin zone is to compress the zone at right angles to the face concerned and so to expand the crystal lattice in the same direction. This expansion is not a property of an atom which can be transferred to any of its alloys but is a characteristic of a structure with sufficient electrons to produce an overlap. The lattice spacings of alloys of Al and In with Cu, Ag, Au and Mg, are examined, and the apparent sizes of the Al and In atoms are discussed and are shown to be in agreement with the theory. New experimental data for the lattice spacings of solid solutions of Al and In suggest that, although in metallic Mg with 2 electrons per atom the overlap of the first Brillouin zone is in the *a* direction only, the structure is so near to the stage at which the *c* overlap sets in that the addition of less than 1 electron per 100 atoms causes the *c* overlap to take place. AUTHORS.

*See also* Abstracts 270, 271.

### COLLOIDS.

***158. Measurement of static and dynamic foams in characteristic units.** G. L. CLARK AND S. ROSS. *Industr. Engng Chem.*, **32**, *pp.* 1594–1598, *Dec.*, 1940.—Dynamic and static foam meters, for use with any gas which will produce foam in any liquid, are described. The results of measurements of dynamic and static foams of egg albumin sols are tabulated for both air and carbon dioxide in the gaseous phase, and comparison is made with corresponding beer foams. Evidence for a reaction between carbon dioxide and egg albumin sol is deduced from foaminess data. Units of foaminess for both static and dynamic foams are discussed and methods of foam measurement classified and correlated. AUTHORS.

**159. Further investigations of the properties of clay suspensions.** G. D. HOBSON. *J. Inst. Petrol.*, **26**, *pp.* 533–564, *Dec.*, 1940.—A number of clay

suspensions have been examined in a capillary tube viscometer under different pressure gradients. Data were obtained on the relationships between rate of flow and pressure gradient, concentration and viscosity, simple and complex suspensions, and on the effects of heating, viscosity-temperature coefficients and ageing. The Hatschek concentric-cylinder viscometer did not prove very satisfactory for examining these suspensions. The phenomenon of sedimentation under shear in a concentric-cylinder viscometer was investigated. Attempts to determine yield values directly by using cylinders and vanes in a torsion apparatus brought to light an interesting feature which is probably coupled with thixotropy. Preliminary work on the estimation of the amount of water bound by different clays was undertaken, and apparently amounts up to 25% or more of the weight of the dry clay are held thus. AUTHOR.

**160. Factors in the stabilization of emulsions.** A. KING AND G. W. WRZESZINSKI. *J. Chem. Soc.*, *pp.* 1513–1521, *Dec.*, 1940.—The influence of electrolytes on the electrokinetic potential of stabilized oil-in-water emulsions has been studied. No relation has been observed between electrical charge and emulsion stability in the absence of chemical reactions. The rôle of lyotropic phenomena is investigated with special reference to concentrated emulsions and the results are discussed and explained. The relation of other fundamental properties of emulsions to stability is considered and some general principles are developed for a rational explanation of the behaviour of certain groups of emulsions. AUTHORS.

**161. Emulsions. I. Mechanism of emulsification of standard emulsion in sodium oleate solution and nature of adsorption at the interface. II. Partial coagulation of standard emulsion in sodium oleate solution.** A. R. MARTIN AND R. N. HERMANN. *Trans. Faraday Soc.*, **37,** *pp.* 25–38, *Jan.*, 1941.—The mechanism of emulsification of a number of organic liquids in *N*/30 sodium oleate by a standard method is discussed and, in particular, the influence of the interfacial tension of the oil against water is described. It is shown that the interfacial film is unimolecular. In standard paraffin and benzene emulsions it consists of acid/soap, whilst in nonyl alcohol emulsions there appears to be a composite film of sodium oleate and alcohol. Emulsions of undecyl alcohol exhibit unusual viscosity phenomena. Experiments on the partial coagulation of a standard emulsion of xylene and other oils in sodium oleate solution by salts of bi- and higher-valent metals are reported. The extent to which the interfacial film of acid/soap is destroyed by the formation of sols of metal/soap in the organic liquid peptized by oleic acid is shown to be an important factor in determining the volume of oil thrown out when the quantity of coagulating salt is less than equivalent to the sodium oleate. AUTHORS.

**162. Relation of fineness to physical requirements.** A. H. M. ANDREASEN. *J. Soc. Glass Technol.*, **24,** *pp.* 166–175, *Oct.*, 1940.—Fineness is considered in relation to homogeneity or to the attainment of a desired texture. Relationships are given between the fineness of a material and its void volume and illustrated by the absorption capacity of a solid suspension as typified by pigment colours. [*See* Abstr. 699B (1940).] AUTHOR.

**163. Influence of radiation on electrolytic coagulation of mastic sols.** F. L. WARBURTON. *Brit. J. Radiol.*, **14,** *pp.* 30–35, *Jan.*, 1941.—Experiments on the effect of ultra-violet and $\beta$ radiation on mastic sol are described. With NaCl the relation between the log. of the dose and the log. of the ratio of the time of coagulation of the un-irradiated sample to that of the irradiated sample is shown to be sigmoidal in each case. It is suggested that the primary reaction is photochemical action on the colloid particles. AUTHOR.

## CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

**164. Crystal structure of Rochelle salt.** C. A. BEEVERS AND W. HUGHES. *Proc. Roy. Soc. A*, **177,** *pp.* 251–259, *Jan.* 10, 1941.—The complete crystal structure of Rochelle salt (sodium potassium tartrate tetrahydrate) has been determined by Fourier and Patterson methods. Some of the difficulties in the application of these methods are discussed. The tartrate molecule is found to lie approximately in 3 planes, the planes of each half of the molecule being inclined at 60° to the plane of the C atoms. The tartrate molecules are bonded to Na and K atoms both directly and through the medium of water molecules. If the water molecules are to preserve their customary tetrahedral bonding it is necessary to suppose that one of the carboxyl groups of the molecule is also a dipole. A reversal of the continuous chain of carboxyl-water-water dipoles is a possible explanation of the peculiar dielectric properties of the salt. AUTHORS.

**165. Graphical method for selecting suitable radiations for the precision determination of non-cubic lattice constants and for indexing back-reflection lines in powder X-ray photograms.** L. A. CARAPELLA. *J. Appl. Phys.*, **11,** *pp.* 800–805, *Dec.*, 1940.—The method involves the use of specially prepared charts. With a knowledge of the approximate lattice constants, positions of diffraction lines with $\theta > 60°$, i.e. back-reflection lines, can be predicted directly from the charts for any common radiation. From the number, distribution and indices of back-reflection lines, a suit-

able target may be chosen for an accurate determination of lattice constants. Furthermore, the charts are useful for predicting positions of $\beta$-lines and for indexing without calculation back-reflection lines in powder X-ray photograms of hexagonal, rhombohedral or tetragonal lattice.

AUTHOR.

**166. Crystal structure of $CuMg_2$.** G. EKWALL AND A. WESTGREN. *Ark. Kemi Min. Geol.*, **14***B*, 7, [8 *pp.*], 1940.—$CuMg_2$ is orthorhombic with $a = 5{\cdot}273$, $b = 9{\cdot}05$, $c = 18{\cdot}21$ A, and 16 molecules per unit cell. The space group is $Fddd(D_{2h}^{24})$. Each Cu atom is surrounded by 8 Mg and 2 Cu atoms, whilst each Mg atom is in contact with 4 Cu and 11 Mg atoms. Inter-atomic distances have been computed. W. R. A.

**167. X-ray analysis of Au-Al alloys.** O. E. ULLNER. *Ark. Kemi Min. Geol.*, **14***A*, 3, [20 *pp.*], 1940.—Au-Al alloys have been investigated by the powder method at 200°, 400°, and 500°, whilst some, containing 50–90 atom. % of Al have been examined at 700° and 900°. Besides the $\alpha$- and *J*-phases, 6 other phases have been found in the system below 500°, but only 2 have been obtained in the pure state, $Au_4Al$ and $AuAl_2$(*H*-phase). The $\alpha$-phase retains the face-centred cubic lattice of Au and the lattice spacing decreases as the amount of Al in the alloy increases; this phase is a solid solution of Al in Au and the saturation limit is 510° at 12·4 atom. % Al. The *J*-phase shows no displacement of the interferences of the face-centred cubic Al lattice, indicating probably that Au forms a solid solution in Al. Powder photographs of $Au_4Al$ are very similar to those of $\beta$-manganese but the crystal structures are not identical. $Au_4Al$ has a simple cubic lattice, parameter = 6·902 A. at 510° and 20 atoms per unit cell. The space group is $T^4$ and the co-ordination number of Al is 6. Previously reported phases have not been obtained in a pure state but it is considered that these have been correctly assigned the formulae $Au_5Al_2$ or $Au_8Al_3$, $Au_2Al$ and AuAl. W. R. A.

**168. Geometrical considerations in glass.** B. E. WARREN. *J. Soc. Glass Technol.*, **24**, *pp.* 159–165, *Oct.*, 1940.—On the basis of the X-ray patterns and assumptions as to the co-ordination between the oxygen atoms and those of silicon or boron, and with the ions $Na^+$ or $Ca^{++}$, theoretical principles are discussed governing glass *v.* crystal formation ; miscibility or immiscibility in glasses; and anomalies in certain physical properties of glasses. AUTHOR.

**169. Mean inner potential of crystals.** S. MIYAKE. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 666–676, *Aug.*, 1940.—Evaluation of the mean inner potential of crystals is attempted from diamagnetic susceptibility data, and the atomic structure factor is provided by some X-ray experiments. The values obtained are compared with those provided by the electron diffraction method. Although in general the methods employed give crude approximations, close agreements are nevertheless obtainable in some cases, e.g. rock salt, but even in cases of bad agreement the sign of the discrepancy generally lies in the expected direction. Data are given for 23 crystals. H. H. Ho.

*See also* Abstract 157.

## DIFFUSION AND OSMOSIS.

**170. Characteristics of thermal diffusion.** S. CHAPMAN. *Proc. Roy. Soc. A*, **177**, *pp.* 38–62, *Dec.* 31, 1940.—When a gas mixture is contained in a vessel in which a steady temperature gradient is maintained, a concentration gradient is in general set up, whose amount is determined by the logarithm of the temperature ratio and by $k_T$, the thermal diffusion ratio ; the general theory of non-uniform gases gives successive approximations to $k_T$, and the first of these, $[k_T]_1$, is accurate within a few per cent. The paper discusses the dependence of $[k_T]_1$ on (i) the ratio of the molecular masses, (ii) their concentration ratio ($c_1$ or $c_2$), (iii) the two ratios of the molecular diameters, inferred from the coefficient of viscosity, to their joint diameter, inferred from the coefficient of diffusion, and (iv) 3 parameters depending on the mode of interaction between the unlike molecules. When this interaction is according to the inverse-power law, the 3 parameters (iv) are all expressible in terms of the mutual force index and $[k_T]_1$ is a function of 5 independent variables. The general nature of its dependence on these variables is discussed, with particular reference to the end values (for $c_1$ or $c_2$ zero) of the thermal diffusion factor $\alpha$, given by $k_T/c_1c_2$. It is shown that $k_T$ may be zero not only when $c_1$ or $c_2$ is zero, but also for at most 1 intermediate mixture ratio. AUTHOR.

**171. Flow of air through porous media.** R. R. SULLIVAN AND K. L. HERTEL. *J. Appl. Phys.*, **11**, *pp.* 761–765, *Dec.*, 1940.—The values of the constant in the equation which relates permeability of a porous medium to the porosity and specific surface of the medium are determined for 3 cases. These experimental values are found to be consistent with the theoretical indications of Fowler and Hertel. AUTHORS.

**172. Properties of the pore system in bricks and their relation to frost action.** R. T. STULL AND P. V. JOHNSON. *Bur. Stand. J. Res. Wash.*, **25**, *pp.* 711–729, *Dec.*, 1940.—The following determinations were made on 7 series of bricks : Percentage of porosity ; variation in porosity within a brick ; permeability to air and water ; the flow of air through 2 members in series ; mean effective

capillary radius and the number of capillaries in an ideal structure, which would have the same permeability value as that determined experimentally for the brick ; saturation coefficient by 48 hr. immersion ; increase in saturation coefficient with repeated freezing and thawing ; resistance of the bricks to failure by repeated freezing and thawing. The data are presented in 14 tables. AUTHORS.

## ELASTICITY AND PLASTICITY.

**173. Observations on the theory of contact pressures.** S. WAY. *J. Appl. Mech.*, **7**, *A*147–*A*157, *Dec.*, 1940.—The stress system in a semi-infinite elastic solid with given normal surface loading is of importance in many problems of machine and structural design and strength of materials. It often happens in such cases that the stresses in which one is primarily interested are those in the surface of the body. This paper presents some observations that can be made regarding the stresses and displacements in the surface. AUTHOR.

**174. Analysis of clamped rectangular plates.** D. YOUNG. *J. Appl. Mech.*, **7**, *A*139-*A*142, *Dec.*, 1940.—This paper attempts to solve the problem of the bending action of rectangular plates clamped at all 4 edges and subjected to lateral loading. Analytical in nature, the author's investigation is based upon the ordinary theory of bending of thin plates as treated in Lagrange's equation of the middle surface. The superposition method is used and applied to a number of loadings not hitherto studied. AUTHOR.

**175. Orthogonally stiffened plate under uniform lateral load.** H. A. SCHADE. *J. Appl. Mech.*, **7**, *A*143–*A*146, *Dec.*, 1940.—The problem of designing structures with orthogonally stiffened plates under lateral loading has been solved approximately by the infinite-strip method and has been applied, for example, to the double-bottom structure of a ship. Under certain conditions where the side ratio, that is the ratio of the longitudinal dimension to the transverse dimension, is small, the approximate solution is inadequate. The author gives an exact solution applicable to all side ratios. AUTHOR.

**176. Thermodynamical theory of the tensile strength of isotropic bodies.** R. FÜRTH. *Proc. Roy. Soc. A*, **177**, *pp.* 217–227, *Jan.* 10, 1941.—By thermodynamic considerations a new formula connecting the tensile strength of an isotropic body with its melting energy and Poisson's elastic constant is developed and found in good agreement with experiments. AUTHOR.

**177. Thermoplastic behaviour of linear and 3-dimensional polymers.** S. S. KISTLER. *J. Appl. Phys.*, **11**, *pp.* 769–778, *Dec.*, 1940.—Thermoplasticity of the linear polymers is shown to have an intimate connection with the character of the side groups on the long-chain molecules. The ultimate tensile strength of 3-dimensional polymers is dependent primarily upon secondary forces and has little connection with the degree of cross-linking. The cross-linking mainly influences the amount of extension under load and the amount of plastic deformation. Calculations are made of the activation energies and viscous volumes accompanying flow, and it is shown that these values differ widely for different types of polymers. These values have been correlated to a limited extent with the physical properties of plastics and, in particular, an explanation is offered of the fact that rubber cannot be "broken down" on a mill in the absence of oxygen. AUTHOR.

**178. Interpretation of torsional frequencies of crystal specimens.** W. F. BROWN, JR. *Phys. Rev.*, **58**, *pp.* 998–1001, *Dec.* 1, 1940.—A crystalline cylinder when subjected to a harmonically varying twisting moment in general not only twists but bends. A correct interpretation of the response frequencies is important in dynamical determinations of the elastic constants of crystals, and it is desirable that the measurements be made under such conditions that a simple formula, similar to that for isotropic materials, may be used without fear of serious error. In static measurements 2 such formulae are required, one for twist with bending prevented and the other for twist with bending unrestrained. It is shown here that each of these is a good approximation in dynamic measurements over certain ranges of frequencies and of specimen lengths, and formulae are derived by which the errors may be estimated. For the sodium and copper-gold crystals on which measurements have been reported the pure torsion formula is a good approximation when no parasitic response frequencies are observable ; but it would cease to be a good approximation for specimen lengths below about 3 cm. AUTHOR.

**179. Impact of a mass striking a beam.** E. H. LEE. *J. Appl. Mech.*, **7**, *A*129–*A*138, *Dec.*, 1940. —A concise approximate solution is developed, making the assumptions that the duration of contact is small in comparison with the period of the fundamental mode of vibration of the beam and that only the fundamental mode of oscillation of the beam need be considered. Results obtained by this method are checked against those determined by the numerical method. Good agreement is reached in some examples, but other results show large errors, both in the contact compression force and in the resulting motion. Light was brought to bear on this difficulty by using a solution based on energy and momentum considerations, giving a curve which supplies a rapid determination of the distribution of energy among the various modes

of vibration of the beam. This curve gives directly the condition for the vibrational energy developed in the beam, due to the impact, to be confined mainly to the fundamental mode. This is shown by examples to be the required condition for the validity of the previous approximate method. The solution using energy and momentum considerations is developed to give the motions of the beam and mass resulting from the impact (free vibrations in the beam and uniform velocity of the mass) so that the subsequent development of the impact can be ascertained and repeated impacts dealt with. The investigation also gives the deflection curves of the beam produced by the impact ; these show a wide deviation from static-deflection curves. AUTHOR.

**180. Vibration patterns of propeller blades.** G. S. BAKER. *Trans. N.-E. Cst Instn Engrs Shipb*, **57** [20 *pp.*], 1940-1941. *Engineering*, **150**, *pp.* 484–486, *Dec.* 20, *and pp.* 518–519, *Dec.* 27, 1940. *Abstract.*—The results are given of vibration tests carried out on 7 cast-iron propellers, 1 ft. in diameter, with 2 blades. The propellers were rigidly bolted to a massive iron plate and excited by means of a small electromagnet with poles approximately $\frac{1}{8}$ in. square and $\frac{1}{8}$ in. apart. This was fed with a.c. superimposed on d.c. and could be moved to any part of the propeller blade. Characteristic frequencies are given for all simple and combinational modes of vibration up to 7 500 c./s. It should be noted that frequencies of 3 200 to 5 400 c./s. with these small propellers would correspond to frequencies of 180 to 300 c./s. with 18 ft. propellers of similar shape. Formulae are derived for the primary flexural and torsional vibration frequencies and the results are discussed, particularly with regard to the effect of blade shape on resonant vibration. A. W.

## HYDRODYNAMICS AND AERODYNAMICS.

**181. Subsonic flow of a compressible fluid past an elliptic cylinder.** I. IMAI AND T. AIHARA. *Rep. Aero. Res. Inst. Tokyo, No.* 194, *pp.* 187–212, *Aug.*, 1940.—A new method is presented of dealing with the flow of a compressible fluid. The method is essentially equivalent to the original Janzen-Rayleigh method but enables the required results to be obtained without recourse to infinite series expansions, thus making the analysis simpler. The method is applied to the subsonic flow of a compressible fluid past an elliptic cylinder at any arbitrary orientation, with any circulation round the cylinder. Formulae are derived for the velocity potential and also for the velocity distribution on the surface of an elliptic cylinder in the absence of circulation. A. W.

**182. Theorems on the motion of incompressible viscous fluids.** G. YOUNG. *Bull. Math. Biophys.*, **2**, *pp.* 145–155, *Dec.*, 1940.—Some standard theorems about the motion of single fluids are reviewed and extended to the case of several fluids moving through each other. Some further results are obtained which do not have a counterpart in the case of a single fluid. AUTHOR.

**183. Turbulence of a tidal current.** J. PROUDMAN. *Proc. Roy. Soc. A*, **176**, *pp.* 449–468, *Nov.* 27, 1940.—A mathematical treatment of the dynamics of a tidal current when turbulence is of significance. The depth of water is taken to be uniform, and the external body forces, the mean velocity of the current and the statistics of turbulence, are assumed uniform over all horizontal planes, though they may vary between the sea surface and the bottom. Discussion of various types of disturbance shows that it is only when viscosity is taken into account that the Reynolds shearing stresses do not vanish. The tides of shallow seas appear to provide the best example in nature of the horizontal uniformity, the freedom from variations of density and the significance of friction, which are postulated throughout the paper. A. W.

**184. Fluid motion near a sill.** K. OTSUBO. *Mem. Fac. Engng Hokkaido*, **6**, *pp.* 1–97, *May*, 1940. *In German.*—The flow over a sill is investigated by models, and the conditions of similarity carefully considered. The formulae obtained can be used to determine the discharge of streams by observations at waterfalls. W. A. R.

## MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

**185. Table of complete elliptic integrals.** A. FLETCHER. *Phil. Mag.*, **30**, *pp.* 516–519, *Dec.*, 1940.—The table was made in connection with work on Laplace coefficients in dynamical astronomy.

**186. Instruments and methods for measuring sensory events.** K. J. W. CRAIK. *J. Sci. Instrum.*, **18**, *pp.* 1–6, *Jan.*, 1941.—All physical measurements depend ultimately on a sensory judgment, such as observing the coincidence of a pointer and a scale mark. The subject is discussed widely and some general conclusions given. Null measurements are of greater accuracy than direct measurements ; this applies equally to audible as well as visual readings. Light intensities can be matched to within 1% over the best range. Visual acuity is such that a misalinement of 2 indicating marks of 5 sec. of arc from coincidence can be detected. The eye has an absolute threshold of $10^{-5}$ equivalent f.c., and a differential brightness threshold of 1%. The ear has an absolute threshold of $10^{-10}$ $\mu$W/cm., a differential intensity threshold of about 15%

and a differential frequency threshold of about 0·2%. Adaptation presents a difficulty, as in comparative and successive brightness measurements. The vernier acuity of the eye has proved to be the most accurate form of judgment. The theory of sensation is discussed. Finally, some new instruments are described. E. H. W. B.

*See also* Abstract 165.

## MECHANICS, QUANTUM.

**187. Influence of the pseudo-scalar field on the classical theory of exchange forces.** E. C. G. STUECKELBERG. *Helv. Phys. Acta*, **13**, 5, *pp.* 347–354, 1940. *In French.*—In an earlier paper [Abstr. 2903 (1940)] the interaction between nuclear particles has been expressed in the form of a series. Møller and Rosenfeld have proposed to combine a vector and a pseudo-scalar part of the field of the nuclear forces in order to improve the convergence of this series. The authors show that this improvement is not very great. Nevertheless, the theory is of interest in view of the complete symmetry between the spatial and the isotopic spin. AUTHOR.

**188. Wave equation of the meson.** M. TAKETANI AND S. SAKATA. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 757–770, *Sept.*, 1940.—The first-order wave equation of the meson proposed by Duffin is discussed. A perturbation theory analogous to that of the Dirac electron is developed, but it is shown to lead to a charge density for the meson which is not positive definite. The time component of Duffin's matrix system has no inverse, which leads to further difficulties. These are removed by reducing the representation of Duffin's matrices from 10-rowed to 6-rowed matrices. G. C. McV.

## RELATIVITY AND ETHER.

**189. Derivation of mechanics from the law of gravitation in relativity theory.** G. L. CLARK. *Proc. Roy. Soc. A*, **177**, *pp.* 227–250, *Jan.* 10, 1941. —The paper gives a general review of an investigation on some problems of motion in the relativity theory. The motion of a single particle in a weak gravitational field is discussed, and the equations of linear and angular motion obtained ; this is followed by brief accounts of the problem of 2 bodies and that of a rotating rod. In each case the equations of motion arise as conditions of integrability of the relativity equations for empty space. Only one of these problems has previously been treated by this method, this being the case of 2 bodies not connected by a material tension. However, this investigation, which was carried out by Einstein, Infeld and Hoffmann, introduces difficult ideas relating to the use of certain spatial surface integrals ; in the present paper the use of these integrals is avoided. A first-order solution for the particular problem is considered and substituted in the quadratic terms of $G_{\mu\nu}$, thus building up a second-order solution. An application to a rotating mass of liquid of constant density is given. AUTHOR.

## SURFACE PROPERTIES.

**190. Surface ageing of solutions.** A. E. ALEXANDER. *Trans. Faraday Soc.*, **37**, *pp.* 15–25, *Jan.*, 1941.—Surface tension, interfacial tension and surface potential measurements have been carried out on aqueous solutions of hydrocinnamic acid, sodium dodecyl sulphate, cetyl sulphonic acid and cetyl pyridinium bromide at concentrations where earlier workers have found anomalously slow adsorption at the air/water interface. This slow adsorption at the air/water interface has been confirmed, and the effect of variation of the conditions, for example, the substrate *p*H, the nature of the interface, addition of capillary active substances to the solution, etc., has been examined. The time factor was found to be eliminated at the oil/water interface and by covering the surface with monolayers of piston oils (e.g. oleic acid and ethyl laurate). Addition of capillary active substances (e.g. propyl alcohol and ethyl acetate) reduced the time factor considerably. With hydrocinnamic acid the time factor was also eliminated by formation of the sodium salt. These new results and earlier work by other authors show that previous theories, based either upon a repulsive electrostatic potential barrier at the interface or upon the formation of poly-molecular layers, are quite inadequate. AUTHOR.

**191. Molecular forces involved in surface formation. I. Surface energies of pure liquids.** J. W. BELTON AND M. G. EVANS. *Trans. Faraday Soc.*, **37**, *pp.* 1–15, *Jan.*, 1941.—The free surface energy, the latent heat of vaporization and the vapour pressure of a liquid, have been calculated from the partition functions of the liquid, surface, and vapour phases. The liquid has been assumed to have a given structure, and the potential-energy change in moving a molecule from the bulk to the surface has been calculated for cubically and hexagonally close-packed molecules. The surface free energies and their temperature coefficients so calculated are in good agreement with experimental values for He, A, Ne, H, O, N, Cl and CO. Rotational states may be assumed absent and the difference between the observed and calculated values of the free surface energy attributed to the ratio of the translational partition functions, which may be expressed as the ratio of a free length in the surface to that in the bulk. The values of this

ratio calculated for the above gases are of reasonable magnitude. Their latent heats and vapour pressures are also shown to be consistent with the theory. AUTHORS.

**192. Calculation of surface energies of liquids.** A. HARASIMA. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 825–840, *Oct.*, 1940.—Surface energies of several liquids are calculated by the aid of data now available. Short-distance regularity of molecular distribution (face-centred cubic lattice) is assumed for He, $H_2$, $D_2$, Ne, $N_2$, A, and surface energies are calculated by summing-up contributions from inter-molecular potential energies. The calculated surface energies agree well with observed values. The relation between the surface energy and the frequency of vibrations of molecules is investigated and the relation found by Weng Wen-Po and Sibaiya and Rama Rao is interpreted by the present theory. Finally, the surface energy of liquid mercury at the melting temperature is calculated by the aid of the atomic distribution function obtained by Boyd and Wakeham from X-ray analysis and the inter-atomic potential energy calculated by Hildebrand, Wakeham and Boyd. AUTHOR.

**193. Properties of coal surfaces.** G. A. BRADY AND A. W. GAUGER. *Industr. Engng Chem.*, **32**, *pp.* 1599–1604, *Dec.*, 1940.—The spheroidal-segment, tilting-plate and protractor methods, have been used to determine the contact and interfacial angles in the systems coal/liquid/gas, and coal/organic-liquid/water. In the first case the liquids used were $H_2O$ and aqueous solutions of $KMnO_4$, $SnCl_2$ and hypophosphorous acid. The gas phase was $CO_2$, propane, $O_2$, $N_2$ or air. In the second case the organic liquids used were $CCl_4$ and $C_6H_6$. There was no appreciable difference in the angle of contact with bubbles of any of the gases on the same coal surface, but there was a perceptible difference in the length of contact time required to develop the maximum angle. The extent to which $CCl_4$ and $C_6H_6$ displace $H_2O$ from an anthracite surface is surprisingly small. A. J. M.

**194. Catalytic activity, crystal structure and adsorptive properties, of evaporated metal films.** O. BEECK, A. E. SMITH AND A. WHEELER. *Proc. Roy. Soc. A*, **177**, *pp.* 62–90, *Dec.* 31, 1940.—Metal films of high and reproducible catalytic activity were obtained by condensation of their vapours on glass at any desired temperature. The catalytic activity was measured by the hydrogenation of ethylene. The crystal structure of these films was investigated by electron diffraction. By controlling the pressure of an inert gas (N, A, etc.) during evaporation of the metals, unoriented and oriented films could be produced at will, and their catalytic activities were compared. Low-pressure adsorption of H at room temperature and of CO at liquid-air temperature revealed that the oriented gas-evaporated Ni films have twice the available surface per g. of randomly oriented high-vacuum films but 10 times the activity. The oriented films have therefore 5 times the activity of unoriented films. Oriented films of an available surface equal to unoriented but of 5-fold activity could also be obtained in high vacuum by evaporation on to oriented films previously produced by evaporation in an inert gas. The activity per unit weight of the films was constant, indicating ready accessibility to the interior of the film by the reacting gases. Adsorption of H was found to be immeasurably fast in all cases. Loss of activity, decrease of hydrogen adsorption and amount of poison, were found to be proportional. The most extensive studies were made on Ni films, but films of Fe, Co, Pd, Pt and Cu, were also investigated and with the exception of Cu similar results were obtained. The enhanced activity of oriented films appears to be associated with the larger distances in the (110) plane of Ni or the (111) plane of Fe. AUTHORS.

*See also* Abstracts 159, 161.

## TIME.

**195. Problem of the isochronous hairspring.** S. GOUDSMIT AND MING-CHEN WANG. *J. Appl. Phys.*, **11**, *pp.* 806–815, *Dec.*, 1940.—Deviations from isochronism for the system of hairspring and balance wheel are treated by a method due to Haag. The results are given a geometrical interpretation. It is shown that the deviations are related to the displacement of the end-point of the hairspring in a set-up in which this end-point is free to move keeping its tangent constant in direction. Such an arrangement can be realized with Bouasse's pendulum. For the so-called helical spring a more accurate solution than Phillips's has been found for the shape of the terminals. Extensive numerical calculations have been made for flat spiral springs and a new simple terminal has been designed. AUTHORS.

## VISCOSITY AND FRICTION.

**196. Viscosity of aqueous solution of pure KBr.** T. OKAYA AND R. TAKEUTI. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 721–733, *Sept.*, 1940.—The coefficient of viscosity, $\mu$, of specially prepared solutions of pure KBr, was measured by the method of the torsional vibration of a hollow cylinder filled with the solution of concentration $c$ and at temperature $\theta = K - 273{\cdot}2$. The following results were obtained : (1) For each definite concentration the Andrade relation $\log \mu = \alpha + \beta/K$ is valid, where $\alpha$ and $\beta$ are coefficients which depend on $c$.

All the Andrade lines pass through a definite temperature point $K_0 = 302{\cdot}4$ or 29·2°C., indicating that the viscosity of the solution becomes independent of $c$ at this temperature ; (2) the relative viscosity, $\eta$, of the solution with respect to pure water is expressed by $\log\eta = A(\sqrt{c})(1 - K_0/K)$ where $A$ is a certain function of $\sqrt{c}$; (3) for the concentration range $(0{\cdot}142 < c < 0{\cdot}846)$, $A = \lambda\ (\sqrt{c} - \sqrt{c_1})$, where $K_0 = 302{\cdot}0$, $\sqrt{c} = 0{\cdot}1941$ and $\lambda = 1{\cdot}9752$ ; (4) for a limited range $(0{\cdot}142 < c < 1{\cdot}0)$, and below $K_0 = 302{\cdot}4$, $\eta$ is always $<1$, while at $K_0$ $\eta = 1$, and above $K_0$ $\eta > 1$. H. H. Ho.

*See also* Abstract 159.

# ASTRONOMY AND ASTROPHYSICS.

## COMETS AND METEORS.

**197. Meteor of May 7, 1928.** F. Watson. *J. Roy. Astr. Soc. Can.*, **34**, *pp.* 418–424, *Nov.*, 1940.—The meteor of May 7, 1928, had a sunlit train visible for 1½ hr. and was photographed by McNichols at Chicoutimi, P.Q. From the train's position with regard to the Cross of St. Anne, visible on the plate, the original photographic scale is found to be 0°·405 per mm. ; $\beta$ and $\theta$ Persei and $\gamma$ Andromedae were also on the plate. A second figure gives observations of the meteor and train with the adopted line of flight. A general discussion of the motions and changing appearances is given. A. S. D. M.

## SUN.

*See* Abstracts 213, 221.

# GEOPHYSICS.

## GEOPHYSICS, APPLIED.

*See* Abstract 220.

## HYDROSPHERE, PHYSICS OF THE.

**198. Experimental investigation of the propagation of tides in parallel and in convergent channels.** J. Allen and J. L. Matheson. *J. Instn Civ. Engrs, No.* 2, *pp.* 107–118, *Dec.*, 1940.—Lamb's and Taylor's theories on the change in tidal amplitude are tested experimentally. The apparatus used consists of 3 model sea-inlets with 2 sets of pointers for water levels. Three ranges of tide (spring, mean and neap) and 2 tidal periods were tested. It is demonstrated that the theory ceases to be valid in a given channel if the depth of water is low, if the tidal period is short enough or if the amplitude generated at the mouth is sufficiently high. The formulae are applicable when (1) tidal range at the mouth does not exceed $h/4$, (2) the length of the channel does not exceed $1{\cdot}30\ c/\sigma$ where $c = \sqrt{gh}$, $\sigma = 2\pi/T$ and $h$ is the mean-tide depth at the mouth. The amplification is confirmed to be greater in a parallel inlet than in a convergent inlet of equal length and mean depth. No significant difference was observed in the behaviour of 2 convergent channels, one of 6° and the other of 13° apex angle. R. S. R.

*See also* Abstract 183.

## LAND, PHYSICS OF THE.

*See* Abstract 200.

## METEOROLOGY.

**199. Effect of shear instability on the transverse circulation in the atmosphere.** H. J. Stewart. *Proc. Nat. Acad. Sci. Wash.*, **26**, *pp.* 604–610, *Oct.*, 1940.—It is assumed that the atmosphere may be treated as a layer of fluid of constant density with the vertical velocities being of small importance, so that the pressure is determined by the hydrostatic law. In addition, the variation of the Coriolis parameter with latitude and the effects of friction are neglected. Investigation of the eddies and the stable vortex motion in the shear fields bordering the westerlies shows that with a strong westerly circulation the ratio of the vorticity N. to that S. of the westerlies is large and 2–3 high-pressure cells are found. The vorticity ratio decreases and the maximum number of cells increases as the circulation decreases. The result is verified by the N. hemisphere mean-pressure charts. R. S. R.

**200. Isostatic control of fluctuations of sea level.** A. C. Lawson. *Science*, **92**, *pp.* 162–164, *Aug.* 23, 1940.—It is shown that, because of isostasy, an increase of thickness of an ice sheet will involve a transfer of rock mass by plastic flow to the ocean with a decreased depth of water. Calcula-

tions regarding the pleistocene Labrador ice sheet when in retreat and the raising of the level of the sea bottom are based on this view. R. S. R.

*See also* Abstracts 209, 237.

## TERRESTRIAL ELECTRICITY AND MAGNETISM.

**201. Production and absorption of mesotrons in the sub-stratosphere.** M. SCHEIN, E. O. WOLLAN AND G. GROETZINGER. *Phys. Rev.*, **58**, *pp.* 1027–1031, *Dec.* 15, 1940.—In a coincidence-counter experiment carried out in an aeroplane at altitudes up to 9·3 km. (22·9 cm. Hg) an attempt was made to observe the production of mesotrons in an 8 cm. lead block by some non-ionizing radiation other than photons. From the results it would seem that the number of mesotrons so created is not greater than about 5% of the total number of mesotrons at this altitude. The experiment was also designed to give the absorption of mesotrons in lead of 19 cm. and 27 cm. thickness as a function of the altitude. From these data and from those obtained previously for 10 cm. of lead an energy spectrum of the mesotrons at an altitude of 6·7 km. is constructed. At this altitude about 33% of all the mesotrons have energies below $5{\cdot}2 \times 10^8$ eV while at sea level a very small fraction of the mesotrons have energies in this range. This is in accord with the finding of many slow mesotrons in the cloud-chamber experiments of Herzog and Bostick at these altitudes. AUTHORS.

**202. Relation between actual and virtual ionospheric height.** H. G. BOOKER AND S. L. SEATON. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 503–515, 1940.—Translation of virtual height of the ionosphere into actual height is achieved by fitting a parabolic maximum of electron density to observations of variations of virtual height with wave frequency. Methods for measuring the thickness of a region and the height of maximum electron density are described and applied. The simplest measure of the actual height of maximum electron density is the virtual height at 5/6ths of the penetration frequency. This measure is found to be remarkably reliable for $F$ region at night. During the daytime it is often necessary to correct $F_1$ observations for presence of $E$ region, and $F_2$ observations for presence of $F_1$ region. A simple technique of correction is described and applied. The disadvantages of minimum virtual height for quantitative study of diurnal variation of ionospheric height are emphasized. AUTHORS.

**203. Ionic equilibrium in the troposphere and lower stratosphere.** O. H. GISH AND K. L. SHERMAN. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 474–491, 1940.—A critical review of the measurements to date and of the equilibrium relations proposed to account for the state of ionization of the lower atmosphere. The relations usually employed appear to express the average relations between the rate of ion production and the numbers of ions and uncharged nuclei present, provided the right combination coefficients are selected. The required values of these coefficients, however, differ considerably from those which have been generally used. Before data are employed in calculation, tests of their consistency should be employed, and the question of the correct weighting of different sets of observations needs attention. J. P. A.

**204. Recent ionospheric researches.** E. V. APPLETON. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 516–521, 1940.—The scale height $H$ for the constituents of the atmosphere of the $E$ and $F$ ionospheric layers can be found from measurements of apparent height of these layers at different frequencies. Recent determinations at Slough and Cambridge give 11·4 km. and 40 km. for the scale heights of $E$ and $F$ in winter. In summer the scale height of $F_2$ increases to 70 km. Estimates of the air density from the scale height figures and from measurements of absorption of radio waves agree in giving about $10^{12}$ and $10^{11}$ molecules per cm$^3$. in the $E$ and $F$ layers, respectively. From the change of noon ionization over the last 9 years it is evident that the ionizing solar radiation increased in intensity by 130% from sunspot minimum to maximum. The existence of a $D$ layer at about 60 km. height is now established and by radio sounding methods a lunar tide in phase with ground-level pressure tides has been found in $E$. Reflection of radio waves in the troposphere appears to be due not to ionized layers but to water vapour discontinuities. J. P. A.

**205. Recombination and attachment processes in the ionosphere.** H. S. W. MASSEY. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 521–523, 1940.—An adequate account of the ionization of the ionosphere must take account of recombination, attachment and detachment processes. The appropriate equations for these (for night conditions) are given and, assuming a constant ratio, $\lambda$, of negative ions to electrons as a necessary expression of dynamical equilibrium between them, it is shown that the recombination coefficient for electrons with positive ions must be increased by $\lambda\alpha_i$ where $\alpha_i$ is the coefficient of recombination for positive and negative ions. To satisfy observations $\lambda$ must be nearly 100 in the $E$ region and about 1 in the $F$ region, results which also satisfy the requirements of d.c. conductivity in the theory of magnetic variations. J. P. A.

**206. Dissipative processes for electrons in the ionosphere.** E. V. Appleton. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 523–526, 1940.—From the equation for ion production in an ionospheric layer and the equation of equilibrium of electrons it is shown that the apparent coefficient of recombination is independent of pressure. This implies that $\alpha_i$ is independent of pressure. It is suggested that the pressure-dependent part of $\alpha_i$, which relates to 3-body encounters, always provides a much smaller contribution than the other part which is known to be independent of pressure. It seems unlikely that photo-detachment is an important factor. It is not certain whether the discrepancy between the values of recombination coefficient for $F_2$ in summer, obtained from radio experiments and from theory, is due to the presence of negative ions or not. J. P. A.

**207. Densities of condensation-nuclei over the North Atlantic Ocean.** F. T. Davies and G. R. Wait. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 457–459, 1940.

**208. Need for measurements to supplement observations of potential gradient and of conductivity at atmospheric electric observatories.** O. W. Torreson and G. R. Wait. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 460–466, 1940.—Taking the observations at Huancayo, Washington and Watheroo as data, variations in the electrical conductivity and ion content of the atmosphere at ground level are discussed. The equation of equilibrium is taken as $q = \alpha n^2 + 2\eta Nn$ where $q$ is the rate of production of small ions, present with the concentration $n$ per cm$^3$., $N$ is the number of large ions per cm$^3$., $\alpha$ and $\eta$ are combination coefficients for small ions with small and large ions of opposite sign, respectively. At Washington $q$ has a diurnal and seasonal variation but no connection with changes of barometric pressure. Among the conductivity results some features, such as the occasional sudden increases of conductivity, can be explained satisfactorily only if other data, such as $q$ or $N$ or both, have been simultaneously measured. The coefficient $\eta$ is not a constant and, since its properties are not known thoroughly, it is necessary to measure all of the quantities $n$, $N$, $q$, before attempting interpretation. J. P. A.

**209. Meteorological effects and their relation to the electrical condition of the lower atmosphere.** G. R. Wait and O. W. Torreson. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 491–500, 1940.—At Watheroo magnetic observatory the atmospheric potential gradient increases when the air is smoke-laden, but the conductivity decreases, so that the air-earth current remains unchanged. Evidently the smoke affects only the lower layers of the atmosphere. At Huancayo the number of condensation nuclei is much diminished and the air-earth current much increased during the rainy season. This is considered to indicate that the nuclei exist at considerable heights at Huancayo. Fluctuations in potential gradient and conductivity at Watheroo are closely associated with variations of wind velocity, although the mechanism of the connection is obscure. J. P. A.

**210. Observatory technique of ionospheric measurements.** L. V. Berkner. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 417–437, 1940.—Discusses in detail the organization of automatic recording, the reduction of observations of ionospheric quantities and the standardization of procedure. Each of the observed quantities should be recorded at least once an hour and more frequently for special events. The photographic records of echoes should register the variation of apparent height with frequency ($h'|f$) and with time ($h'|t$) on one frequency. Apparatus has been constructed to give complete $h'|f$ records automatically 4 times an hour. From the records the maximum ion density, the height of this maximum, the minimum height of the layer and the minimum frequency for reflection, are found. The procedure for measuring the records and for special observations is described. J. P. A.

**211. Improvements in technique at magnetic observatories in the U.S.A.** H. E. McComb and J. W. Joyce. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 404–412, 1940.—The correct orientation of variometers is described, and tests for temperature-coefficient of magnets, moment of inertia, compass testing, etc. A new computing board has been devised for scaling magnetograms. Some survey results are given, with comparative readings over an extended period. E. H. W. B.

***212. Improvements in methods of field observations in the U.S.A.** J. W. Joyce and H. E. McComb. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 393–413, 1940.—Three new instruments are described, the chief being the quartz horizontal magnetometer. The basis of the instrument is a small permanent magnet suspended by a quartz fibre. Great precision is attained and horizontal intensity may be measured in about 5 min. For the single measurement of declination a pivoted instrument is sometimes used, known as the transit magnetometer. The construction of this is entirely non-magnetic with the exception of the pivot and the magnet. The third instrument is the field Z-variometer which gives readings of variation in the vertical component directly, thus avoiding separate measurements of dip and horizontal intensity. This is also a precision instrument, employing a compound cobalt steel magnet carried on a quartz knife edge. Constructional

features are given, together with precautions necessary for the degree of precision attained.

E. H. W. B.

**213. Relation between solar and magnetic phenomena.** J. COULOMB. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 391–393, 1940. *In French.*

**214. Various hypotheses regarding the origin and maintenance of the earth's magnetic field.** E. H. VESTINE, M. A. TUVE AND E. A. JOHNSON. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 354–359, 1940.

**215. Potential of the earth's magnetic secular variation.** E. H. VESTINE. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 382–391, 1940.—Starting from charts showing the geographical distribution of secular variation (*SV*) over the earth's surface for the epoch 1920–25 new charts for the N. (*X*) and E. (*Y*) components of *SV* are prepared, and these are extended to cover the polar regions, although with much less certainty. The line integrals of the *SV* field along parallels of latitude and longitude do not vanish as a rule, but the data are considered too inaccurate to justify any conclusions. Line integrals over tesserae of 60° angle symmetrical about the equator do tend to vanish. Assuming that the main contribution to the *SV* field is of internal origin, a system of currents flowing in a thin shell just below the ground, and sufficient to account for the *SV* field, is delineated. Alternatively, this chart may represent the distribution of magnetization of a magnetic shell below the surface. The vast scale of the phenomenon is revealed by the charts. J. P. A.

**216. Determination of secular variation in declination in New England from magnetic polarization of glacial varves.** A. G. MCNISH AND E. A. JOHNSON. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 339–347, 1940.—The secular change of direction of the earth's magnetic field has so far been estimated from tests on igneous rocks, but more conclusive results should be obtainable from sediments which have been undisturbed since their formation, such as the clays left at the retreat of the last glaciation. Dating is also easier owing to the varved character of these clays. For this purpose cubical specimens of dimension 1·5 cm. are removed by a standard procedure from a cleared vertical face of clay. The specimen is then rotated at the centre of a coil connected to an amplifier, commutator rectifier, and galvanometer. The commutator is mounted on the same rotating shaft as the specimen, and the brushes may be set to give zero galvanometer deflection. Their position then determines the direction of magnetization of the specimen. From tests on layers of New England clays representing periods of deposition of 200 and 500 years, the average declination was found 30° W. and 30° E., respectively, of the present declination, the two layers being from 2 different geological series. Curves show that the declination varied in a manner similar to that observed in recent years. Tests are also made on marine sediments. J. P. A.

**217. Comparative study of 11-year component of daily variation of declination at different points of the earth.** H. AND MME. LABROUSTE. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 319–324, 1940. *In French.*

**218. Disturbance-field of magnetic storms.** E. H. VESTINE. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 360–381, 1940.—Extending the work of Chapman [Abstr. 1083 (1939)] on the average magnetic field characteristics of magnetic storms, the current system there proposed is examined to check its agreement with observation of individual hours of magnetic storms. Four storms in 1932–3 are selected and from data giving the mean hourly disturbance vectors for about 25 stations north of lat. 55° the necessary current systems are plotted. While the characteristics of the earlier diagrams for the main phase reappear, considerable differences in the current systems appear as the storm proceeds from the initial to the main phase, and these are pointed out in detail. The omission of currents encircling the globe at several earth-radii distance seems to introduce no difficulty, and the currents plotted are considered as flowing wholly in the atmosphere at an altitude of 100–150 km.

J. P. A.

**219. Severe magnetic storm of April, 1938.** A. G. MCNISH AND H. F. JOHNSTON. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 348–353, 1940.

**220. Application of telluric currents to surface prospecting.** M. SCHLUMBERGER. *Bull. Int. Union Geod. and Geophys., No.* 11, *p.* 467, 1940.

**221. Variation in earth-current activity with the sunspot-cycle.** W. J. ROONEY. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 467–473, 1940.—From the records of the earth-current stations at Watheroo, Huancayo and Tucson, the mean ranges of the diurnal variation of the current are compared statistically with corresponding sunspot numbers. For the 11-year period 1927–37 the correlation factor is greater than 0·90 for Watheroo and Huancayo, and Tucson records show a similar high correlation for a shorter period. After the elimination of the seasonal variation the correlation remains at about 0·80.

J. P. A.

***222. Design for travelling electromagnetic standard.** E. A. JOHNSON. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 325–332, 1940.—Describes a field magnetometer for rapid measurements of

the magnetic elements, having high stability and low sensitivity to temperature changes. It consists of a pair of approximately Helmholtz coils wound with duralumin ribbon on a duralumin former, insulated by anodizing, and a secondary coil rotatable by spring motor or by hand about an axis perpendicular to that of the primary. The primary coils are oriented with their axis in the direction of the field to be measured and the current adjusted to balance the field at the secondary which, with an a.c. amplifier, acts as a null detector. Details of operation are described and inaccuracies arising from errors of orientation are discussed. It is claimed that under field conditions an accuracy of 1 in 10 000 can be maintained for 2–3 years without recalibration. C. E. W.

***223. Measurement of susceptibility of materials used in magnetometers.** E. A. JOHNSON AND W. F. STEINER. *Bull. Int. Union Geod. and Geophys., No.* 11, *pp.* 333–339, 1940.—Describes a very sensitive astatic magnetometer designed to measure volume susceptibilities down to $2 \times 10^{-8}$ e.m., c.g.s. units, and polarizations producing fields of $0{\cdot}05\ \gamma$ at the deflecting magnet. Two small alnico magnets rigidly connected by phosphor bronze wire are supported by 10 cm. of quartz fibre $7\ \mu$ thick. To make the system almost perfectly astatic the stronger magnet is demagnetized by a pair of coils clamped to the instrument and carrying a.c. The astaticism is tested by adjusting the rest position of the magnets, when perpendicular to the earth's field, to be that of zero torsion of the fibre. The lower magnet is at the centre of a small Helmholtz coil system which may be used in null experiments. A part of the apparatus to be tested is brought very close to the magnetometer and the deflection compared with that produced by a full-scale model of the part, filled with copper oxide. Susceptibilities are then proportional to deflections. The apparatus is tested on chemical materials of known susceptibility. J. P. A.

**224. Transactions of Washington meeting Sept. 4-15, 1939.** *Bull. Int. Union Geod. and Geophys., No.* 11, [556 *pp.*], 1940.—Contains Minutes of the meetings; National Reports; Reports of special committees on magnetic character figures, distribution of observatories, auroral and solar studies, magnetic charts, classification, standards and comparisons, lunar and geophysical relations, and statistics; various Abstracts and Communications [Abstr. 202-223 inclusive, 238, and 211B (1940)]; Proposals and Resolutions. ED.

# RADIOACTIVITY.

**225. Scattering matrix of radioactive states.** G. BREIT. *Phys. Rev.*, **58**, *pp.* 1068–1074, *Dec.* 15, 1940.—The method of complex eigenvalues is generalized to many dimensional problems by means of the scattering matrix. It is essential to allow for the existence of a background matrix on which the resonance is superposed. The radioactive state, i.e. the state with complex energy for which waves in all disintegration channels are outgoing, determines the damping constants of the resonance formulae. Phase constants responsible for displacements of observable resonance peaks with respect to the real part of the complex eigenvalue of the energy are also determined by the radioactive state. The background matrix is restricted by the damping constants and phase constants to a considerable extent, leaving free in its specification an $(n-1)$-dimensional symmetric unitary matrix for the case of $n$ channels. The equations presented do not include the case of continuously variable energy distribution among disintegration products. AUTHOR.

**226. Application of the coincidence method for measurements of short life periods.** J. ROTBLAT. *Proc. Roy. Soc. A*, **177**, *pp.* 260–271, *Jan.* 10, 1941.—A method is described for the determination of short radioactive and nuclear life periods. It consists in varying the length of the electrical impulses produced in a coincidence arrangement of 2 Geiger-Müller counters. The method can be used for the measurement of life periods in the range $10^{-7}$ to $10^{-1}$ sec. The half-life period of radium C′ has been measured in this way and found to be $1{\cdot}45(\pm 0{\cdot}05) \times 10^{-4}$ sec. Experimental evidence has been obtained for the absence of $\gamma$-rays in the transition radium C′ → radium D, and some conclusions regarding the lifetimes of excitation states of radium C′ have been drawn. The determination of the intensity of weak sources and of the efficiency of Geiger counters for various types of radiation is described. The effect of a time lag in Geiger counters on the measurement of coincidences is discussed. AUTHOR.

**227. Assignment and prediction of radioactive periods.** G. R. DICKSON AND E. J. KONOPINSKI. *Phys. Rev.*, **58**, *pp.* 949–951, *Dec.* 1, 1940.—Families of odd nuclei differing from each other only by $\alpha$-units show some evidences of a certain type of regularity in their stability against $\beta$-processes. The assumption that a similar regularity holds for all such families permits the unique assignment to the correct isotope of many known radioactive

periods and the prediction of many yet unknown lifetimes. AUTHORS.

*228. **Velocity spectrum of α-particles.** R. RINGO. *Phys. Rev.*, **58**, *pp.* 942–948, *Dec.* 1, 1940.—A 60° magnetic α-particle spectrograph has been constructed and used on a number of natural α-particle emitters, with photographic plates to detect the particles. The energy of the main group of proto-actinium α-particles was found to be 5·053 ± 0·007 eMV. With the thinnest sources of Po, ThC and ThC′ α-particles, as many as 10% of the particles were found to have energies 5% or more below the energy of the maximum of any one group. AUTHOR.

229. **Proton-induced radioactivity of Mn.** A. HEMMENDINGER. *Phys. Rev.*, **58**, *pp.* 929–934, *Dec.* 1, 1940.—The reaction $Cr^{52}$ (*p*, *n*) $Mn^{52}$ at 6·6 eMV proton energy produces isomers with period 21·3 min. and 6·5 days. These are positron emitters with maximum positron energy of 2·2 eMV (21 min.) and 0·77 eMV (6·5 day). The γ-ray spectrum for each isomer has been investigated. The γ-radiation in the 6·5-day activity is so intense that 95% of these disintegrations must be due to *K*-electron capture ; this is followed by emission of probably 2 γ-rays. In the remaining 5% the positron emission is followed by 3 γ-rays. The threshold for the 21 min. activity and the yield for both periods have been determined. AUTHOR.

230. **Electrostatic deflection studies of α-particles.** L. C. MILLER. *Phys. Rev.*, **58**, *pp.* 935–942, *Dec.* 1, 1940.—A technique is described for studying nuclear reactions in which short-range α-particles are produced with a yield that is too small for the direct application of the electrostatic deflector. In preliminary experiments a strong polonium source is used to supply α-particles to the deflector, and a group of these α's, homogeneous in energy, passes through the deflector and enters a variable-pressure absorption cell and ionization chamber. Cut-off pressures determined for various α-particle energies result in a calibrated cell which can then be used to determine the α-particle energies in nuclear disintegrations. Application of this method to $Li^6(p,\alpha)He^3$ results in a *Q* value of 3·94 ± 0·08 eMV. The calibration, extending in α-particle energy from 1 to 1·8 eMV, is also used to determine the slope of the range/energy curve. AUTHOR.

# RADIATION.

## ABSORPTION.

231. **Changes in absorption spectrum of Pb and Ni films at low temperatures.** C. F. SQUIRE. *J. Appl. Phys.*, **11**, *pp.* 779–780, *Dec.*, 1940.—The temperature dependence (298°K. to 80°K.) of the absorption spectrum of Ag, Cu, Cd, Al, Sn, Sb, Pb and Ni, has been studied. Only Pb and Ni showed a relative change ; Pb films transmit more ultra-violet light at 80°K. than at 298°K. ; Ni films transmit less visible light at 80°K. than at 298°K. AUTHOR.

232. **Broadening, asymmetry and shift, of Rb resonance lines under different pressures of He and A up to 100 atm.** CH'EN SHANG-YI. *Phys. Rev.*, **58**, *pp.* 1051–1058, *Dec.* 15, 1940.—A new absorption tube was constructed which made feasible the study of the pressure effects of foreign gases on the absorption lines of alkali vapours of homogeneous density and temperature. In addition to He and A at pressures up to 100 atm., H was used up to 20 atm. Up to relative density 46 the broadening is proportional to the concentration of He or A gas. The slopes of the half-width/relative-density curves are 0·735 $cm^{-1}$. and 0·594 $cm^{-1}$. per unit relative density of He for $^2P_{3/2}$ and $^2P_{1/2}$ components, respectively, and the corresponding values for A are 0·855 $cm^{-1}$. and 0·627 $cm^{-1}$. per unit relative density. He produces a violet, A a red asymmetry. The degree of asymmetry increases as the concentration of foreign gas increases and is comparatively much greater for A. For A the asymmetry of the $^2P_{3/2}$ component is greater than that of the $^2P_{1/2}$ component, while for He the reverse is true. A produces a greater shift than He. The former produces a strong red shift, the latter a violet shift. For both gases the shift of the $^2P_{1/2}$ components is greater than that of the $^2P_{3/2}$ component. For He the shift appears to be proportional to the relative density, and the shift of the longer wavelength component is about twice as great as that of the shorter wavelength component, while for A the shifts for the doublet components are quite close, and the relation between shifts and relative densities obeys in general the 3/2 power relationship. Optical collision diameters as calculated from the half-width data are 13·37 Å and 7·753 Å for Rb-A and Rb-He, respectively. From the measurements of the amount of total absorption from the line contours *f* values and the transition probabilities were evaluated. AUTHOR.

**233. Pressure effects of H and N on the second doublet of Rb principal series.** CH'EN SHANG-YI AND PAO CHIA-SHAN. *Phys. Rev.*, **58**, *pp.* 1058–1061, *Dec.* 15, 1940.—The effects were studied at pressures up to 13 atm. Both for H and N the $^2P_{3/2}$ component broadens more conspicuously than the $^2P_{1/2}$ one, and the relationship between the half-width and the relative density is linear. N produces a red shift for both components, while H has a weaker red shift for $^2P_{3/2}$ and a stronger violet shift for $^2P_{1/2}$. The departure from a linear relationship between shift and the density of the perturbing gases is quite manifest. Study of the line contours reveals marked asymmetry, toward the red in the case of N and slightly toward the blue for H. The relationship between the half-width and the shift is discussed. AUTHORS.

**234. Spectrophotometric determination of vitamin A.** D. T. EWING, J. M. VANDENBELT, A. D. EMMETT AND O. D. BIRD. *Industr. Engng Chem.* (*Analytical Edition*), **12**, *pp.* 639–644, *Nov.* 15, 1940.—The vitamin A content of fish liver oils can be accurately determined by finding the extinction coefficient at 328 m$\mu$ of the oil dissolved in isopropyl alcohol. A carefully controlled procedure must, however, be used. A. J. M.

**235. Spectrographic characteristics of vitamin A materials.** R. L. MCFARLAN, P. K. BATES AND E. C. MERRILL. *Industr. Engng Chem.* (*Analytical Edition*), **12**, *pp.* 645–647, *Nov.* 15, 1940.—The ultra-violet absorption curves of substances containing vitamin A have been investigated. There is a continuous change in the absorption of U.S.P. reference cod liver oil over an extended period of time. Beer's law holds for vitamin A over the range 3 100–3 500 Å. A. J. M.

**236. Near ultra-violet absorption spectra of benzene and its derivatives. I. Chlorobenzene. II. Bromobenzene.** K. ASAGOE AND Y. IKEMOTO. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 678–690, *Aug.*, 1940.—The absorption spectrum of $C_6H_5Cl$ at 2 700–2 400Å has been investigated. The vapour absorbs about 9 times as strongly as $C_6H_6$ and the spectrum is much more complicated than that of the latter. The vibrational analysis of the spectrum is given. With increase of temperature the bands become broader and more diffuse, and at 100° the continuous absorption extends towards longer wavelengths, indicating the probable occurrence of pre-dissociation. The ultra-violet absorption spectrum of $C_6H_5Br$ lies in the same region as that of $C_6H_5Cl$ and is similar in appearance. $C_6H_5Br$ absorbs light about 3 times as strongly as $C_6H_5Cl$. A vibrational analysis is given. A. J. M.

## EMISSION.

**237. Seasonal variations of cosmic-ray intensity and temperature of the atmosphere.** A. DUPERIER. *Proc. Roy. Soc. A*, **177**, *pp.* 204–216, *Jan.* 10, 1941.—A careful examination of the upper atmospheric data for Europe and the U.S.A. indicates that the mean temperature of the upper atmosphere in spring differs from that in summer more than from that in winter. The magnitude of the seasonal difference depends on the height of the atmosphere which is considered and is a maximum at a height of about 6 km. and changes sign at heights above 12 km. This lag in the warming of the atmosphere in spring is found to be paralleled by a lag in the diminution of intensity of the cosmic-rays. A similar phenomenon is found in autumn. The cooling of the atmosphere as a whole is found to be less between summer and autumn than between autumn and winter, though the effect is markedly less definite than in spring. The cosmic-ray variations are found to be correlated more closely with the mean temperature of the atmosphere up to 16 km. than with the temperature near the ground. This provides additional support for the theory of Blackett that the temperature variation of penetrating cosmic rays is related to the instability of the mesotron. The temperature coefficient of the cosmic rays as deduced from the seasonal data is found to be 0·18%/°C. and this is in rough agreement with the prediction of the theory. AUTHOR.

**238. The 27-day and 13·5-day waves in cosmic-ray intensity and their relation to corresponding waves in terrestrial magnetic activity.** S. E. FORBUSH. *Bull. Int. Union Geod. and Geophys.*, *No.* 11, *pp.* 438–452, 1940.—Cosmic-ray data obtained during 1936–8 at Huancayo and Christchurch (N.Z.) are analysed statistically, and no evidence is obtained of a genuine periodic variation, although the variations are quasi-persistent for both 27- and 13·5-day periods. A marked correspondence is found between the variations at the two stations and this must indicate a world-wide origin. In 21 out of 24 months the mean cosmic-ray intensity at Huancayo was lower for the internationally magnetically disturbed days than for the quiet days. Results suggest that an external magnetic field is superposed on the earth's permanent magnetic field at times of magnetic disturbance, but they do not support the hypothesis of a solar magnetic moment inclined to the axis of rotation of the sun. J. P. A.

**239. Counter studies on cosmic rays at sea level.** G. O. ALTMANN, H. N. WALKER AND V. F. HESS. *Phys. Rev.*, **58**, *pp.* 1011–1017, *Dec.* 15, 1940.—Rossi transition curves for lead up to 400 g./cm$^2$. were studied with a triple-coincidence counter arrangement in various geometrical configurations with shower angles from 4° to 60° ; variations of cosmic-ray intensities are recorded simultaneously with a 2-fold vertical-coincidence set and every

point of the transition curves corrected accordingly. Even with small-angle showers, in an arrangement practically identical with Bothe and Schmeiser's, no second maximum of the Rossi curve could be found. Time variations are recorded with a vertical-coincidence set giving daily mean values for 1 year in New York City. The temperature coefficient for the winter months (— 0·155%/deg. C.) is about 5 times greater than the one for the summer months (— 0·033). The total seasonal variation (maximum in winter, minimum in summer and fall) amounts to about 5·6% and is reduced to about 2·8% when the values are corrected for the same temperature. Thus a true seasonal variation with an amplitude of ± 1·4% was found, in agreement with measurements elsewhere with ionization chambers. Various non-periodic changes in cosmic-ray intensity were studied : the effect of the passage of cold and warm fronts, of the passage of barometric depressions and the effect of magnetic storms. The magnitude of these effects, as recorded in a vertical-coincidence set, agrees very well with the effects found with ionization chambers. AUTHORS.

**240. Genetic relation between the electronic and mesotronic components of cosmic rays near and above sea level.** G. BERNARDINI, B. N. CACCIAPUOTI. B. FERRETTI, O. PICCIONI AND G. C. WICK. *Phys. Rev.*, **58,** *pp.* 1017–1026, *Dec.* 15, 1940.—The hypothesis that the cosmic-ray electrons observed at sea level are mostly due to the disintegration of the mesotrons has been tested (*a*) by comparing the ratio (soft component)/(hard component), found at sea level in free air, with the same ratio found at 2050 m. under a dense absorbing layer ; (*b*) by comparing the Rossi curves for small showers under the same conditions ; (*c*) by an especially detailed study of the increase of the soft component with increasing altitude. The results indicate that the proper lifetime of the mesotron is at least 4 μsec. and that the soft radiation observed at sea level is not entirely due to secondary processes of the mesotron. AUTHORS.

## INTERFERENCE, DIFFRACTION AND SCATTERING.

**241. General interferential method.** L. STURKEY AND B. P. RAMSAY. *Phil. Mag.*, **31,** *pp.* 13–23, *Jan.*, 1941.—Although interferometry deals with various instruments, each treated individually, it appears possible to derive a general intensity equation directly applicable to all. In deriving such an equation it is assumed that the number of beams to be considered must be indefinite. For convenience these beams are grouped into compatible sets, but for perfect generality the number of beams in each set and the number of sets remain undefined. Special cases of the resulting intensity equation are discussed. The process of applying this general intensity function to specific optical problems is defined as the interferential method. AUTHORS.

## PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

**242. Bromine-sensitized photodecomposition of ozone.** R. MUNGEN AND J. W. T. SPINKS. *Canad. J. Res. B*, **18,** *pp.* 363–371, *Nov.*, 1940.—Bromine acts as a sensitizer for the photodecomposition of ozone. The quantum efficiency for the bromine-sensitized reaction is about 30. The effect of variation of wavelength, concentration, light intensity and temperature, has been studied. The quantum efficiency is the same for wavelengths 5460 and 3650 Å and is independent of the ozone concentration but varies somewhat with bromine concentration and light intensity. The temperature coefficient is 1·01. Under certain conditions an oxide of bromine, produced photochemically, can be isolated. AUTHORS.

**243. Extragranular factors in photographic sensitivity.** S. E. SHEPPARD AND C. L. GRAHAM. *Commun. Kodak Res. Lab., No.* 777. *Photogr. J.*, **80,** *pp.* 470–479, *Dec.*, 1940.—Three of the very important factors which influence photographic sensitivity externally to the grain and which are connected through their influence on halogen removal are : (i) the *p*H of the vehicle ; (ii) the *p*Ag of the vehicle ; (iii) the water content of the vehicle. These factors are considered in detail and their close connection demonstrated. By this means the contradictory statements which exist concerning (iii) are reconciled. It is shown that the attack of aqueous bromine solutions on silver sulphide is not favoured but rather slowed down by raising the *p*H of the solution, whether the silver sulphide be free or incorporated in gelatin. This is evidence against the view that silver sulphide is the chief halogen acceptor in the photographic reaction. It is, therefore, more probable that it is gelatin which, in this rôle, induces the specific behaviour of the gelatino-silver halide emulsion in regard to *p*H, moisture and *p*Br. It is pointed out that the fundamental reaction is *per se* reversible, and that the removal and fixation of halogen are of equal moment, for latent-image formation and persistence, with the acceptance and fixation of electrons. The paper is replete with data and photographic illustrations. H. H. HO.

## PHOTOMETRY.

**244. Photometric procedure using barrier-layer photocells.** L. E. BARBROW. *Bur. Stand. J. Res.*

*Wash.*, **25**, *pp.* 703–710, *Dec.*, 1940.—A procedure is described whereby barrier-layer photocells, corrected so as to have a spectral response curve simulating the ICI luminosity curve, are used in the photometry of light sources of various colours and in the determination of the transmission factors of coloured filters. The procedure involves a determination of the illumination response curve of the cell used, a method of avoiding the difficulties incident to cell fatigue and a means for correcting for the improper spectral sensitivity of the cell. The method of correcting for the difference between the spectral response of the cell used and the ICI luminosity curve embodies essentially the procedure recommended in 1937 by the International Committee of Weights and Measures for the photometry of light sources which differ in colour. Results obtained using the recommended procedure are given. AUTHOR.

## REFLECTION, REFRACTION AND DISPERSION.

**245. Effect of surface strain on the minimum of reflectivity of silver.** Y. KIDANI. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 750–756, *Sept.*, 1940.—Using a thin silver plate, $0{\cdot}22 \times 7 \times 5{\cdot}5$ mm., whose minimum reflectivity was at 3 202 Å, with a tension of 4 kg. the minimum was found at 3 201 Å, while 9 kg. tension moved it to 3 206 Å, no further change being observed and the elastic limit being reached at 10 kg. loading. In compression tests on a specimen whose no-load minimum was at 3 220 Å a load of 80 kg. shifted the minimum to 3 218 Å, 150 kg. to 3 217 Å, no further shift being observed, the elastic limit being at 200 kg. The results are discussed and formulae given for the dependence of the location of the minimum on (*a*) temperature and (*b*) applied strain. A. W.

**246. Effect of composition and other factors on the specific refraction and dispersion of glasses.** J. C. YOUNG AND A. N. FINN. *Bur. Stand. J. Res. Wash.*, **25**, *pp.* 759–782, *Dec.*, 1940.—Seven of the better known specific-refraction ratios were examined for their comparative applicability to glass. It is shown by a comprehensive statistical treatment of available data (including many new data) that, of these ratios, only the Gladstone-Dale formula possesses to a satisfactory degree each of the following desirable features : (1) It varies linearly with chemical composition and with the square of the wave number of the incident light ; (2) for a given composition and wavelength of light it is substantially the same for both the vitreous and crystalline states ; (3) for the vitreous state it is independent of thermal history. Gladstone-Dale factors for 47 oxides as constituents of glass (and corresponding factors derived from non-glassy substances) are given. These factors are shown to be related to the periodicity of the elements. Specific dispersion factors, useful for computing the dispersion index or $\nu$-value of a glass, are given for 32 oxides. AUTHORS.

## SPECTROSCOPY.

**247. Qualitative spectrochemical analysis in agriculture and geochemistry.** S. S. BALLARD. *J. Appl. Phys.*, **11**, *pp.* 750–758, *Dec.*, 1940.

**248. Hyperfine structure and intensities of the forbidden lines of Pb I.** S. MROZOWSKI. *Phys. Rev.*, **58**, *pp.* 1086–1093, *Dec.* 15, 1940.—The hyperfine structure of the forbidden lines of Pb is studied in order to establish the intensity rules. The lines here investigated arise from transitions between the levels of the $6p^2$ configuration and show hyperfine structure because of the presence of a nuclear spin and magnetic moment in the isotope 207. They are excited very intensely by 3 m. standing waves in He at about 5 mm. pressure, containing saturated Pb vapour at 800°C. The type of discharge and its dependence on several factors are studied. Intensities are quantitatively determined from calibrated plates. For the quadrupole line $\lambda$5 313 the intensity ratio (3 : 2) and the ratio of the distances from the centre of gravity are found to agree with the Rubinowicz formulae transcribed for hyperfine structure by Opechowski (selection rule $\Delta F = 0, \pm 1, \pm 2$). For the magnetic dipole line $\lambda$4 618 these ratios agree with the well-known rules for electric dipole transitions (2 : 1). In the case of $\lambda$7 330, which is of mixed type, the intensities are approximately those for ordinary electric dipole transitions, showing that this line is mostly magnetic dipole radiation and that for such radiation the selection rule $\Delta F = 0, \pm 1$ holds. An upper limit of the admixture of electric quadrupole can be evaluated from these measurements. The measurements also show that the total transition probabilities for electric quadrupole and magnetic dipole are independent of the existence of a magnetic moment of the nucleus since they are the same for the various isotopes. Finally, the relative intensities of these 3 lines and of 2 others, $\lambda$4 659 and a newly found line at $\lambda$9 250($^3P_2 - {}^1D_2$), have been measured for comparison with theory. The results are $I_{4618} : I_{5313} = 5{\cdot}0 \pm 0{\cdot}3$ and $I_{4659} : I_{7330} : I_{9250} = 0{\cdot}023 \pm 0{\cdot}006 : 1 : 0{\cdot}84 \pm 0{\cdot}07$. These ratios are independent of the furnace temperature. The ratio $I_{5313} : I_{4659}$ varies somewhat with temperature, changing from about 15 to 12 in going from the lower to the higher temperatures. AUTHOR.

**249. Spectroscopic evidence of the $B_2$ molecule and determination of its structure.** A. E. DOUGLAS AND G. HERZBERG. *Canad. J. Res. A*, **18**, *pp.* 165–

174, *Nov.*, 1940.—In a discharge in helium with a trace of boron trichloride a new band system is found. The observation of isotope bands and in particular of an intensity alternation in the fine structure shows that the system is due to the diatomic boron molecule $B_2$. The $B_2^{11}$ band heads are represented by the formula $\nu_H = 30\,546{\cdot}1 + (929{\cdot}3\nu' - 2{\cdot}75\nu'^2) - (1035{\cdot}2\nu'' - 9{\cdot}58\nu''^2)$. The bands consist of single $R$ and $P$ branches. The fine structure analysis yields the following rotational constants: $B_e' = 1{\cdot}160$, $B_e'' = 1{\cdot}212$, $\alpha' = 0{\cdot}011$ and $\alpha'' = 0{\cdot}014$ cm$^{-1}$. From these the internuclear distances $r_e' = 1{\cdot}625$ and $r_e'' = 1{\cdot}590$ Å are obtained. It is shown that in all probability the system represents a $^3\Sigma_u^- - {}^3\Sigma_g^-$ transition, the lower state being the ground state. From the intensity alternation in the $B_2^{11}$ bands the spin of the $B^{11}$ nuclei is found to be 5/2. This value is in disagreement with recent theoretical predictions based on the Hartree as well as on the $\alpha$-particle model of the nucleus. Finally, a comparison with the other homonuclear diatomic molecules of the second period of the periodic system is made, as well as a comparison of $B_2$ and $C_2$ with $B_2H_6$ and $C_2H_6$. AUTHORS.

**250. Zeeman effect of Kr.** J. B. GREEN, D. W. BOWMAN AND E. H. HURLBURT. *Phys. Rev.*, **58**, 1094–1098, *Dec.* 15, 1940.—Measurements on the Zeeman effect about 130 lines in the spectrum of neutral Kr have yielded a large number of additional $g$ values to those already given by Pogany. In several cases the results differ sharply from Pogany's, especially in the case of $4p^5 5s$. The $g$ sum rule has been verified for $4p^5 5s$, $4p^5 5p$ and for $J = 2$ of $4p^5 6p$, but for this last configuration interaction with $4p^5 5f$ causes the breakdown of the rule for $J = 1$. Other anomalies in the $g$ values are discussed. AUTHORS.

## X-RAYS.

**251. Quantum efficiency of Geiger-Müller counters for X-ray intensity measurements.** H. M. SULLIVAN. *Rev. Sci. Instrum.*, **11**, *pp.* 356–362, *Nov.*, 1940.—A description is given of the use of G.M. counters to measure the intensity of feeble X-rays using the photo-electric action of the X-rays on the gas in the counter and on the cathode material (Zr) of the counter. By comparing the counting rate when the X-ray beam passes only through the gas in the chamber and when it also strikes the cathode material, the quantum efficiency of the counter can be determined. Knowing this quantum efficiency and the counting rate, the author makes a determination of the absolute intensity of the X-ray beam in photons/cm².sec. Measurements of the intensity made with two different counters filled with different gases agree to within 3%. G. O. B.

**252. Application of X-rays to the study of alloys.** H. LIPSON. *Nature, Lond.*, **146**, *pp.* 798–801, *Dec.* 21, 1940.—The study of the equilibrium of binary and ternary systems by X-rays is briefly outlined and indications are given of the way in which such a study can give information not obtainable by other means. In ternary systems in particular the application of X-rays has led to the discovery of new intermetallic compounds. The explanation of the physical properties of alloys in terms of their structures is referred to, and the deduction of crystal structure from composition is considered. In connection with the latter a brief outline is given of the Brillouin zone theory which, it is concluded, must form the main basis of the study of equilibrium in alloy systems. J. T.

**253. X-ray crystallography and the chemistry of the steroids. I.** J. D. BERNAL, D. CROWFOOT AND I. FANKUCHEN. *Philos. Trans. A*, **239**, *pp.* 135–182, *Dec.* 31, 1940.—A survey has been made of the X-ray crystallography of some 80 sterol derivatives. The measurements include determinations of unit cell size, space group and some data on the crystal morphology and optics. In 3 cases Patterson projections have also been derived from the intensities of the X-ray reflections of the $h0l$ planes. These confirm earlier deductions on the shape and size of the sterol molecules, and the details of the patterns can also to some degree be correlated with the actual arrangement of the C atoms in the sterol ring system and with the positions of the Cl and Br atoms. The arrangement of the molecules in the crystal units is closely that given by the preliminary examination from the optic orientation, and this has therefore been employed to suggest in each of the remaining sterol crystal structures the probable molecular arrangement. The X-ray data have been applied particularly among the higher plant and animal sterols to identify individual constituents, to distinguish additional crystal forms, and to characterize new sterols and relate these to previously known compounds (e.g. a sterol from rubber). Molecular-weight measurements have been carried out. AUTHORS.

*See also* Abstracts 165, 167.

# HEAT.

## CONDUCTION.

**254. Pressure of electron gas and thermal conductivities of metals.** M. SATÔ. *Sci. Rep. Tohôku Univ.*, **29**, *pp.* 304–314, *Sept.*, 1940. *In German.*—It is shown that the thermal conductivity of a metal in which a uniform heat flow is established can be derived from considerations of the gradient of pressure in the electron gas which results from the gradient of temperature. The expression obtained for the thermal conductivity when the electron gas is assumed to be fully degenerate is similar to that obtained by Sommerfeld, except that the numerical coefficient is about 16% greater, whilst for the non-degenerate case the resulting expression only differs from that of Lorentz in that the coefficient is about 19% smaller. R. W. P.

**255. Heat conduction problem.** R. V. CHURCHILL. *Phil. Mag.*, **31**, *pp.* 81–87, *Jan.*, 1941.—The problem considered is that of determining the temperatures in 2 semi-infinite solids, of different materials and initial temperatures, after being brought into contact with one another. Solutions had been obtained by Tranter [Abstr. 194 (1940)] using contour integrals, and by Carslaw [Abstr. 120 (1941)] using the Laplace Transformation. The latter method is employed by the present author, who shows that the solution is unique when the complete boundary conditions are stated. He concludes that Tranter's solution does not satisfy the required conditions at the surface of separation of the two media. R. W. P.

## FUSION AND SOLIDIFICATION.

**256. Softening point of glass.** J. T. LITTLETON. *J. Soc. Glass Technol.*, **24**, *pp.* 176–185, *Oct.*, 1940.—The author discusses the 2 generally accepted definitions of softening point based, respectively, on the fibre-extension method and on the thermal-expansion method ; describes the fibre method used for many years by himself ; gives comparative results for 4 glasses by the 2 methods ; and recommends the fibre-extension method on the grounds of speed, accuracy and the possibility of referring the softening point to a definite viscosity value. AUTHOR.

## THERMODYNAMICS.

*See also* Abstract 176.

# ACOUSTICS.

**257. Air jet with velocity exceeding that of sound.** J. HARTMANN AND F. LAZARUS. *Phil. Mag.*, **31**, *pp.* 35–50, *Jan.*, 1941.—Photographs are given of the periodic structure exhibited by air jets with a velocity exceeding that of sound, together with Pitot tube measurements under different experimental conditions. Formulae of the Prandtl type are given and discussed, together with a comparison of the velocity-ratio curves derived from the Pitot tube measurements and from measurements of the Mach angle, which is $\frac{1}{2}$ the apex angle of the conical wave. A. W.

**258. Disc recording.** S. J. BEGUN. *Proc. Inst. Radio Engrs, N.Y.*, **28**, *pp.* 389–398, *Sept.*, 1940.—It is shown that the lack of standardization in the recording characteristics of commercial shellac pressings makes it difficult to provide correct equalization for play-back. A compromise equalization is suggested. It is also pointed out that new lightweight pick-ups with their permanent jewel styluses do not require the abrasive surfaces which are provided in present shellac pressings. Considerable improvement can be expected with respect to the signal/noise ratio of recordings if the general use of lightweight pick-ups makes it possible to use better disc materials. Vertical *v.* lateral recording is briefly discussed and it is pointed out that, even for transcription work, the likelihood is that lateral recording will regain its predominance. Some general problems of disc recording are discussed and the design of a cutter is outlined. The relative merits of different methods of regulating the depth of cut are discussed. The requirements for matching a cutter to an amplifier for different frequency characteristics of cut are also explained. AUTHOR.

**259. Applications of direct-reading pitch and intensity recorder.** J. OBATA AND R. KOBAYASHI. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 691–704, *Aug.*, 1940.—The pitch and intensity recorder previously described has been utilized to study the performances of famous coloratura sopranos. Records of the same passage sung by different individuals are reproduced and discussed, special reference being made to normal vibrato effects, usually ranging in pitch about half a tone, and vibrato effects of wider extent amounting to what is known as a trill. A study is also made of the " Utai," a Japanese recitative chant, as performed by a number of the best Japanese singers. A. W.

# ELECTRICITY AND MAGNETISM.

## CONDUCTION AND DISCHARGE IN GASES.

**260. Theory of the cyclotron.** R. R. Wilson. *J. Appl. Phys.*, **11**, *pp.* 781–796, *Dec.*, 1940.—The processes of formation of the initial ions in the cyclotron are reviewed, after which the various processes by which the ions are lost from resonance are considered. A theory of the loss of ions by collision or by electron capture is given and is compared with measurements made on the variation of the high-energy beam current with gas pressure : satisfactory agreement is found. The inhomogeneity of the magnetic field of the 60 in. Berkeley cyclotron has been measured, and an analysis of the electric and magnetic focusing in that cyclotron is made. Rose's work on the loss of ions resulting from their getting out of phase with the r.f. voltage is applied to the calculation of $V_0$, the voltage necessary to apply to the dees just to get a beam. As an example, the value of $V_0$ is computed for the 60 in. cyclotron and is found to be in good agreement with the directly measured value. The wandering of the ion path is reviewed and is applied to the calculation of the inhomogeneity of the energy of the emergent beam. Measurements made on the homogeneity of the energy of the protons from the 37 in. cyclotron are compared with the calculations. Finally, the question of shimming the magnetic field of a cyclotron is considered. It is suggested that the magnetic field be made to decrease from the centre with a constant $dH/dr$. For this shape of magnetic field analytic expressions are derived for the magnitudes of $dH/dr$ and $V_0$, and methods for attaining such a field are suggested. Author.

**261. Mobilities in hydrogen at high current-densities.** W. H. Bennett. *Phys. Rev.*, **58**, *pp.* 992–997, *Dec.* 1, 1940.—The conditions in an investigation of the silent electric discharge from sharp points and fine wires in hydrogen at atmospheric pressure are such that the discharge itself purifies the gas from electron-attaching impurities, so that the conditions of the discharge are productive of free-electron conduction. Measurements are made of the generalized coefficient of mobility for the drift of free electrons in hydrogen, and of the mobility of hydrogen positive ions in hydrogen. Past observers have usually had doubts concerning the purity of the gas prepared by chemical means, but the results here reported involve a demonstrably sustained purification during the measurement itself. Author.

**262. Relations between rotational temperatures and gas temperatures in h.f. discharges.** T. Horie. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 787–804, *Oct.*, 1940.—The rotational temperatures have been determined over a wide temperature range from the (01) band of the CO Ångström system under h.f. ring and glow discharge excitations, an oscillation circuit of 40 kc./s. being used. In the case of ring discharge the rotational temperature agrees closely with the true temperature of the gas, which is defined as the mean translatory energy of the gas molecules and is measured with a gas thermometer. The author has also investigated the relation between rotational temperatures and furnace temperatures and has tried to explain it on the hypothesis that the collisions of ions accelerated by the field with neutral molecules raise the temperature of the gas molecules on the whole.

Author.

**263. Theory of recombination.** G. Jaffé. *Phys. Rev.*, **58**, *pp.* 968–976, *Dec.* 1, 1940.—A general formula for $\alpha$, the coefficient of recombination of ions in gases, is developed. The evaluation of the formula depends on the relative values of 3 linear quantities : the mean free path of the ions, $\lambda$, the mean distance between ions of different signs, $\bar{r}$, and the well-known parameter $a_0 = e^2/(kKT)$. In case $\lambda \ll a_0$ the mechanism of recombination depends on the ratio $a_0/\bar{r}$. If $a_0/\bar{r}$ is large, the migration of the ions under their mutual attraction prevails ; in the opposite case, $a_0/\bar{r} \ll 1$, diffusion is the decisive feature and a formula which is practically identical with that of Harper obtains. The case $\lambda \gg a_0$ is treated by a method previously developed by the author. The theory is in fair agreement with such experimental data as are available for the region of transition.

Author.

## CONDUCTION IN SOLIDS AND LIQUIDS.

*See* Abstract 287.

## DIELECTRICS AND CAPACITANCE.

**264. Dielectric constants of metallic sulphates containing various amounts of water of crystallization.** C. K. Cheng. *Phil. Mag.*, **30**, *pp.* 505–515, *Dec.*, 1940.—The dielectric constants of salts with varying amounts of water of crystallization have been measured. Samples of the powdered salt are suspended in a graded series of mixtures of two liquids which give liquid media of different dielectric constants. The mixture is found which has the same dielectric constant as the salt ; this is determined by finding experimentally the particular mixture, the dielectric constant of which is not changed by the addition of the powdered salt. The capacitance of the condenser cell containing the samples is measured in the circuit of a crystal-controlled oscillator of about 2 Mc./s. frequency.

The molecular polarization of the water in the salts is practically constant and only slightly higher than that of ice. The results indicate that the water molecules retain their integrity as individual molecules bound in much the same manner as those in ice. AUTHOR.

*See also* Abstract 164.

## ELECTROCHEMISTRY.

**265. Vanadium ion oxidation—reduction potentials.** A. B. HART AND J. R. PARTINGTON. *J. Chem. Soc.*, *pp.* 1532–1539, *Dec.*, 1940.—The e.m.f.'s of cells containing 4- and 5-valent V ions in solutions of HCl and $H_2SO_4$ have been measured and the standard potentials calculated. The formulae of the 4- and the 5-valent V ions are discussed and it is shown that their electrochemical behaviour in acid solutions is best explained on the assumption that they exist as $VO^{\cdot\cdot}$ and $VO_2^{\cdot}$, respectively. AUTHORS.

**266. Factors determining electrolytic dissociation. II. The free energies of dissociation of salt molecules in aqueous solution.** W. J. C. ORR. *Phil. Mag.*, **31**, *pp.* 51–61, *Jan.*, 1941.—This paper describes results of researches continuing those published previously [Abstr. 5220 (1934)]. Calculations are made of the total heats, the entropies and the free energies of dissociation, of various types of salt molecules in water. From the results quantitative estimates are made of the degree of dissociation of these salts in aqueous solution. AUTHOR.

**267. Standard electrode potential of Na.** E. R. SMITH AND J. K. TAYLOR. *Bur. Stand. J. Res. Wash.*, **25**, *pp.* 730–746, *Dec.*, 1940.—From measurements of the cell Na(s)/NaI (in dimethylamine)/Na(0·0651% amalgam) and the cell Na (0·0651% amalgam)/NaCl (0·05 or 0·1 *m.*), AgCl(s)/Ag(s), the standard electrode potential Na(s)/$Na^+$ over the temperature range of 5° to 40°C. was obtained with the aid of values of the standard electrode potential of the $Ag/AgCl_2$ electrode, previously determined by Harned and Ehlers, and of the activity coefficients of solutions of NaCl, previously determined at 25°C. by Brown and MacInnes. The activity coefficients were corrected to the other temperatures by the use of data on heats of dilution determined by Gulbransen and Robinson. The final results are expressed by an equation and values of changes in free energy, entropy and heat content accompanying the reactions corresponding to various combinations of the cells, are calculated. AUTHORS.

***268. Pyrex all-glass micro-electrophoresis cell.** D. R. BRIGGS. *Industr. Engng Chem.* (*Analytical Edition*), **12**, *pp.* 703–705, *Nov.* 15, 1940.—The cell is simple to construct ; it can be used for measurements of migration velocity of particles in organic or aqueous solutions, and contamination from stopcock lubricant or electrode liquid is eliminated. The working electrodes can be removed and their contents changed easily. The electrical circuit is shown, and the field strength during measurements on organic liquids is determined by means of a special arrangement employing a valved voltmeter. N. M. B.

**269. Electrolytic polishing. II.** W. C. ELMORE. *J. Appl. Phys.*, **11**, *pp.* 797–799, *Dec.*, 1940.—[See Abstr. 4388 (1939)]. From the assumptions underlying the diffusion theory of electrolytic polishing 2 quantitative current/time relations are deduced and compared with the behaviour of a copper/orthophosphoric-acid cell. One equation relates the current through the cell to the time required for the growth of the concentration layer necessary for polishing. The other equation describes the fall in limiting current once the layer is formed. Both equations are in accord with the results of some simple experiments designed to test them. AUTHOR.

## ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

**270. Molecular anisotropy of urea and of related compounds.** K. LONSDALE. *Proc. Roy. Soc. A*, **177**, *pp.* 272–280, *Jan.* 10, 1941.—The magnetic anisotropy of urea has been measured and compared with that of the carbonate and nitrate groups. It does not appear that the hydrogen bonds contribute appreciably to the anisotropy ; the latter indicates about the same degree of resonance in all three groups. The anisotropy of the refractivities is greater in urea than in the carbonate group, showing that the $(NH_2)^-$ radical must be much more polarizable than the $O^=$ ion, allowance being made for the inter-ionic distances. Urea nitrate, urea oxalate, cyanuric acid dihydrate and anhydrous cyanuric acid, all crystallize in layer structures, as shown by cleavage, X-ray data, magnetic and optical observations. The magnetic anisotropy of urea nitrate and urea oxalate is approximately additive, but that of cyanuric acid dihydrate is considerably larger than the additive value for 3 urea molecules, being comparable with that of other cyanuric ring compounds. Although the molecules in each layer must be joined together by hydrogen bonds, it does not follow that hydrogen bonds form the links between successive layers, since the layer to layer distance of 3·05 ± 0·10 Å is characteristic even of cyanuric triazide, which contains no hydrogen bonds. AUTHOR.

**271. Magnetic and other properties of free electrons in graphite.** N. GANGULI AND K. S. KRISHNAN. *Proc. Roy. Soc. A*, **177**, *pp.* 168–182, *Jan.* 10, 1941.—Graphite crystals have a large free-

electron diamagnetism, which is directed almost wholly along the hexagonal axis. Over the whole range of temperature over which measurements have been made, from 90° to 1270°K., this free-electron diamagnetism of graphite per carbon atom is found to be equal to the Landau diamagnetism per electron of a free-electron gas obeying Fermi-Dirac statistics and having a degeneracy temperature of 520°K. From this experimental result it is concluded (*a*) that the number of free or mobile electrons in graphite is 1 per carbon atom ; (*b*) that the effective mass of these electrons for motion in the basal plane is their actual mass, showing that the movements in this plane are completely free and uninfluenced by the lattice field ; (*c*) that their effective mass for motion along the normal to the basal plane is enormous, about $190^3$ times the actual mass, which indicates that the mobile electrons belonging to any given basal layer of carbon atoms are tightly bound to the layer, though, according to (*b*) they can migrate quite freely over the whole of the layer ; (*d*) that this tight binding accounts for the observed low degeneracy temperature of the electron gas in the crystal. The electron gas in graphite thus conforms to a simple model which is easily amenable to theoretical treatment, and it has a low degeneracy temperature which is conveniently accessible for experimenting. It therefore forms a suitable medium for studying the properties of an electron gas. The conclusions stated are in accord with the quantal views of the electronic structure of graphite, and also with its Brillouin zones. There is one zone which can just accommodate 3 electrons per atom, and the energy discontinuities at all of its boundary surfaces are large. There is a bigger zone which can just accommodate all the 4 valency electrons, but the energy discontinuities at those of its faces that are perpendicular to the basal plane are very small.

AUTHORS.

**272. Electromagnetic properties of mesotrons.** H. C. CORBEN AND J. SCHWINGER. *Phys. Rev.*, **58,** *pp.* 953–968, *Dec.* 1, 1940.—A general theory describing particles of unit spin and arbitrary magnetic moment is developed and applied to the motion of such particles in a Coulomb field. In the particular case of magnetic moment unity (Proca theory) the exact equations for the radial components of the wave functions possess regular solutions only for those states ($j=l\neq 0$ and $j=0$, $l=1$) in which the orbital angular momentum $l$ is a constant of the motion. For particles possessing a magnetic moment of 2 mesotron magnetons the radial equations are free of singularities for all states but 2 : $j=1$, $l=0$ and $j=0$, $l=1$. The cross-section for a fractional energy-transfer to electrons by energetic mesotrons is calculated for the various simple possibilities of mesotron spin $\sigma$ (0, $\frac{1}{2}$, 1) and magnetic moment $\mu$ (arbitrary except for zero spin). Criteria for the validity of these formulae indicate that the region of applicability for the theory $\sigma=1$, $\mu\neq 1$ is more limited than that for $\sigma=1$, $\mu=1$ (Proca).

AUTHORS.

**273. Mesons in a Coulomb field.** I. TAMM. *Phys. Rev.*, **58,** *p.* 952, *Dec.* 1, 1940.—A short discussion is given of the fact that the present theory of charged mesons of spin unity leads to untenable results in the majority of nuclear problems and in the case of the interaction of mesons with the electromagnetic field. In particular, the problem of mesons in the field of a point charge is discussed and is shown to have no solution. It is suggested that the reason for the breakdown of the theory lies in the neglect of the finite size of the particles. G. O. B.

**274. Theory of the magnetic resonance method of determining nuclear moments.** A. F. STEVENSON. *Phys. Rev.*, **58,** *pp.* 1061–1067, *Dec.* 15, 1940.—Two refinements of the theory of the resonance method of determining magnetic moments as given by Rabi are considered quantitatively : (1) A correction is included because of the fact that an oscillating, rather than a rotating, field is used ; (2) the end effect pointed out by Millman is taken into account. The results caused by (1) agree with those found by Bloch and Siegert, but the method of calculation is simpler. In the case of (2) it is shown that, under assumptions which mean that the effect is small and which are usually well satisfied in practice, the effect can be worked out without making more than very general assumptions as to the nature of the field in the end regions. Results are given for the displacement of the maximum, and the asymmetry in the curve, which depend on the sign of the magnetic moment. The sign of the displacement is in agreement with experiment, but that of the asymmetry is not ; the discrepancy can, however, be explained when account is taken of the inhomogeneity of the velocities in the beam. The effects increase as the square of the amplitude of the oscillating field.

AUTHOR.

**275. Intensity changes in Cameron bands of CO excited by electron impact.** G. E. HANSCHE. *Phys. Rev.*, **58,** *pp.* 1075–1077, *Dec.* 15, 1940.—Relative intensities of the $^3\Pi-{}^1\Sigma$ Cameron bands and the $^1\Pi-{}^1\Sigma$ fourth positive bands of CO excited by impact of electrons of various energies at various pressures indicate that (1) intense Cameron bands can be obtained at pressures up to 0·025 mm., in contrast with an upper limit of 0·005 mm. found in electrodeless discharge experiments, and (2) the excitation function of the Cameron bands

has 2 maxima, like that of a $^3P$—$^1S$ atomic transition. AUTHOR.

**276. Neutron studies of order in Fe-Ni alloys.** F. C. NIX, H. G. BEYER AND J. R. DUNNING. *Phys. Rev.*, **58**, *pp.* 1031–1034, *Dec.* 15, 1940.—Neutron transmission measurements are used to study order in Fe-Ni alloys. The difference in neutron transmission between fully annealed and quenched alloys when plotted against the Ni content displays a broad peak around $Ni_3Fe$ and falls to vanishingly small values near 35 atom.% Ni and pure Ni. The higher the degree of order the greater the neutron transmission. The substitution of 2·3 atom.% Mo or 4·1 atom.% Cr for Fe in the annealed 78 atom.% Fe-Ni alloy caused a decrease in the neutron transmission, relative to the annealed 78 atom.% Fe-Ni alloy, of 15·6% and 21·2%, respectively. The cold working of an annealed binary 75 atom.% Ni alloy, a treatment known to produce disorder, gave rise to a decrease of 20·6% in neutron transmission. AUTHORS.

**277. Thresholds for the proton-neutron reactions of Li, Be, B and C.** R. O. HAXBY, W. E. SHOUPP, W. E. STEPHENS AND W. H. WELLS. *Phys. Rev.*, **58**, *pp.* 1035–1042, *Dec.* 15, 1940.—The energy threshold has been measured with a boron trifluoride ionization chamber, surrounded with paraffin, as a neutron detector. The energy of the protons was calibrated against the 0·862 eMV F $(p, \gamma)$ resonance. With $H_2^+$ and $H_3^+$ this calibration was extended to 1·724 eMV and 2·586 eMV. The thresholds are : $Li^7$, 1·86 eMV ; $Be^9$, 2·03 eMV ; $B^{11}$, 2·97 eMV and $C^{13}$, 3·20 eMV. From these values can be calculated the mass differences $Be^7$—$Li^7$=0·87 eMV, $B^9$—$Be^9$=1·08 eMV, $C^{11}$—$B^{11}$=1·97 eMV and $N^{13}$—$C^{13}$=2·22 eMV. $B^9$ is shown to be certainly unstable with respect to disintegration into $Be^8+H^1$. The $N^{13}$—$C^{13}$ difference agrees closely with the maximum positron energy from $N^{13}$ and thereby confirms the voltage scale. AUTHORS.

**278. Protons from C and Al bombarded by deuterons.** H. L. SCHULTZ, W. L. DAVIDSON, JR. AND L. H. OTT. *Phys. Rev.*, **58**, *pp.* 1043–1047, *Dec.* 15, 1940.—The design of a cloud chamber and the technique of its use are described. With it a study of the protons from deuteron bombardment of C and Al has been made. The group corresponding to the ground state of $C^{13}$ appears to be single. The protons from $Al^{27}$ show a general distribution in agreement with the work of McMillan and Lawrence ; but analysis into groups is difficult as there appear to be many such, with small spacing. Curves are shown from which any group structure can be inferred. The homogeneity of the deuteron beam was tested by scattering the deuterons from a thin gold foil : it is homogeneous to within 0·15 eMV. AUTHORS.

**279. Protons from the separated isotopes of C and Ne under deuteron bombardment.** H. L. SCHULTZ AND W. W. WATSON. *Phys. Rev.*, **58**, *pp.* 1047–1050, *Dec.* 15, 1940.—The protons arising from the bombardment by 2·54 eMV deuterons of $CH_4$ gas enriched in $C^{13}$ isotope and neon enriched in $Ne^{22}$ have been studied with a cloud chamber. It is shown that the yield of long-range protons from the $C^{13}(dp)C^{14}$ reaction is less than 4% of the yield of shorter-range protons from the $C^{12}(dp)C^{13}$ reaction at this deuteron energy. This low yield means that the half-life of $C^{14}$ discovered by Ruben and Kamen is considerably less than their estimate and is probably about 100 years. In neon the longest range group of protons discovered by Pollard and Watson is shown to be complex, with an indicated doublet width of the ground state of $Ne^{21}$ of 0·44 eMV. The only proton group definitely indicated for the $Ne^{22}$ bombardment occurs at about 30 cm. range. AUTHORS.

**280. Inelastic scatttering of a beam of particles by hydrogen and helium.** K. C. KAR. *Phil. Mag.*, **30**, *pp.* 487–504, *Dec.*, 1940.—Previous work on elastic scattering [Abstr. 340 (1938)] is extended to include inelastic scattering in H and He causing excitation. Theoretical deductions are compared with the available experimental data, most of which are considered to be suitable only for qualitative comparison. Satisfactory agreement is found with the experiments of Mohr and Nicoll. Van Atta's experiments show disagreement with the theory but reasons are given for regarding the comparison as superficial. The ratio of the inelastic to elastic scattering found by Dymond and Watson is much higher than theory would indicate. The experiments of Hughes and West on the inelastic scattering of electrons in He are also considered, but no definite conclusion is arrived at since the theory applies only to nuclear scattering. F. C. C.

**281. Polarization of electrons.** K. KIKUCHI. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 805–824, *Oct.*, 1940.—Polarization of electrons by double 102° scattering has been investigated on the basis of the magnetic spectra at azimuthal angles of 0° and 180° for various velocities of the incident beam. In comparing the partial areas of the distribution curves of the last-scattered electrons at azimuthal angles of 0° and 180° for elastic scattering alone, large asymmetry has been found, in agreement with the results of Mott [Abstr. 2983 (1932).] The magnetic spectra are similar to those found by Wagner [Abstr. 2287 (1930)]. Polarization and depolarization of the scattered electrons are discussed on the basis of the behaviour of the magnetic spectra in double scattering. AUTHOR.

**282. Mobility of positive ions in their own gas.** R. J. MUNSON AND A. M. TYNDALL. *Proc. Roy. Soc. A*, **177**, *pp.* 187–191, *Jan.* 10, 1941.—Values for the mobility of positive ions of Ne in Ne, A in A, Kr in Kr, and Xe in Xe have been obtained in pure gas. It is possible to deduce the mobility of an ion of the same mass as the gas atom from the known values for alkali ions in the gas on the assumption that the same mass relationship holds. In each case the observed value is considerably less, the ratio of the two being of the order of 0·60–0·75. This result may be attributed to the phenomenon of electron exchange in the case of ions in their own gas which does not arise with alkali ions. The variation of mobility with field $E$ and pressure $p$ has been studied. In Kr and Xe there is a marked fall of mobility with increase of $E/p$, at higher values the velocity of the ion increasing in a linear manner with increase of $(E/p)^{\frac{1}{2}}$. AUTHORS.

**283. Mobility of alkali ions in gases. IV. Measurements in gaseous mixtures.** H. G. DAVID AND R. J. MUNSON. *Proc. Roy. Soc. A*, **177**, *pp.* 192–199, *Jan.* 10, 1941.—[*See* Abstr. 3741 1939).] The mobilities of some of the alkali ions have been measured in binary mixtures of the inert gases. Blanc's relation that the reciprocal of the mobility is a linear function of the concentration of one of the constituents is accurately obeyed in all cases except for $Li^+$ in He-Xe mixtures, where the maximum deviation is 4%. With clustered $Li^+$ ions in mixtures of water vapour and an inert gas deviations from this simple relation are observed, increasing in magnitude progressively with the density of the gas. These deviations, due to the polar nature of the water molecule, can be explained by assuming a gradual increase in the size of the clustered ion with increase in the percentage of water vapour. AUTHORS.

**284. Mobility of alkali ions in gases. V. Temperature measurements in the inert gases.** K. HOSELITZ. *Proc. Roy. Soc. A*, **177**, *pp.* 200–204, *Jan.* 10, 1941.—The variation with temperature of the mobility of $Li^+$ ions in He, $K^+$ ions in A, $Rb^+$ ions in Kr and $Cs^+$ ions in Xe has been measured over a considerable range of temperature. Comparison of the results with existing classical theories suggests that the approximate agreement found by Pearce over a similar range of temperature for $Cs^+$ and $Na^+$ in He does not hold in general. A quantum mechanical treatment for each individual case seems to be required and for this purpose the experimental data here recorded should be of value. AUTHOR.

***285. Improved pole-piece construction of the objective lens of a magnetic electron microscope.** A. PREBUS. *Canad. J. Res. A*, **18** *pp.* 175–177, *Nov.*, 1940. [See Abstr. 3014 (1939)].

*See also* Abstract 169.

## ELECTROSTATICS.

**286. Electrification of powdered insulators.** A. FLEMING. *Proc. Phys. Soc., Lond.*, **53**, *pp.* 51–53, *Jan.*, 1941.—Experiments are described whereby the production of a negative charge, as a result of the fall of a dielectric powder from a metal or glass receptacle into a metal container, is demonstrated. It is necessary that a good insulator, such as powdered sulphur or silica, be employed and, in the case of the latter, it must be previously very well dried by heating. By means of a rotating cylinder a small quantity of powder may be utilized to give an unlimited supply of charge. It is concluded that, when dielectric particles strike a metal surface with some velocity, electrons tend to pass from the latter to the former. The negatively charged particles are capable of acting as condensation nuclei in steam. A. M. T.

## MAGNETISM AND ELECTROMAGNETISM.

**287. Magnetic properties of the perfect conductor and the superconductor.** Z. MIKURA. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 733–746, *Sept.*, 1940.—It is shown that a body of very large conductivity with a great number of electrons moving freely at random behaves in a magnetic field like a superconductor ; also that the conduction electrons in a normal metal may yield quite a different type of diamagnetism in addition to the ordinary Landau's diamagnetism. This work tells against the view, based on the Meissner-Ochsenfeld effect [*cf. Naturwiss*, **21** (1933), 787], that the magnetic induction in the interior of the superconductor is always equal to zero, even if the transition from the normal state occurred in a magnetic field ; superconductivity cannot be interpreted as the limiting case of infinite conductivity. H. H. Ho.

**288. Field dependence of the intrinsic domain magnetization of a ferromagnet.** T. HOLSTEIN AND H. PRIMAKOFF. *Phys. Rev.*, **58**, *pp.* 1098–1113, *Dec.* 15, 1940.—The basis of the treatment is the exchange interaction model amplified by explicit consideration of the dipole-dipole interaction between the atomic magnets. Approximations appropriate to low temperatures and equivalent to those used by Bloch in his derivation of the $T^{3/2}$ law are introduced. The resultant expression for the intrinsic volume susceptibility decreases slowly

with increasing field ; at high fields the functional dependence is as the inverse square root of the field. The variation with temperature is linear ; at room temperature and for fields of about 4000 gauss, the order of magnitude of the (volume) susceptibility is $10^{-4}$. The results are compared with experiment and satisfactory agreement is found. AUTHORS.

**289. Magnetic properties of the iron-group anhydrous chlorides at low temperatures. I. Experimental.** C. STARR, F. BITTER AND A. R. KAUFMANN. **II. Theoretical.** C. STARR. *Phys. Rev.*, **58,** *pp.* 977–992, *Dec.* 1, 1940.—The magnetic susceptibility of these chlorides has been studied as a function of field strength up to 32000 gauss and as a function of temperature down to 13·9°K. Those compounds whose room-temperature susceptibility characteristic indicates a positive Curie temperature also show a field-strength dependence of the susceptibility at 13·9°K. and 20·4°K. Chromic chloride has a very steep magnetization curve at these low temperatures, with a large initial susceptibility increasing with decreasing temperature. Ferrous, cobaltous and nickelous chlorides have an S-type magnetization curve characterized by a small initial susceptibility which decreases with decreasing temperature, followed by a very large susceptibility and eventual approach to saturation, both increasing with decreasing temperature. The susceptibility of many of the compounds reaches a maximum at temperatures which do not appear to be correlated with the presence of field dependence, but these temperatures do correspond to the temperatures of known specific-heat anomalies. [See Abstr. 252 (1940).] The predictions of paramagnetic theory are compared with the room-temperature results, and an attempt is made to explain some of the departures from theory in terms of the crystalline field. The low-temperature experimental anomalies require the development of a theory of metamagnetism. The assumption is made that at temperatures below the Curie point neighbouring atoms behave as groups which are spontaneously formed at the Curie point. The atomic magnetic moments within each group are assumed to be either parallel or antiparallel to each other, and the antiparallel arrangement is assumed to have the lowest energy. The theory developed on these assumptions satisfactorily explains the general behaviour of the metamagnetic chlorides ($CrCl_3$, $FeCl_2$, $CoCl_2$ and $NiCl_2$) and also gives a qualitative explanation of the behaviour of the other anhydrous chlorides which exhibit a minimum in the reciprocal susceptibility/temperature curve but do not show any field dependence of the susceptibility. AUTHORS.

**290. The electromagnetic 2-body problem.** J. L. SYNGE. *Proc. Roy. Soc. A*, **177,** *pp.* 118–139. *Dec.* 31, 1940.—The paper contains a direct attack on the electromagnetic 2-body problem, based on the hypotheses (i) that the bodies are particles, (ii) that the fields are given by the retarded potential, (iii) that the force on a particle is the Lorentz ponderomotive force (without a radiation term). A method of successive approximation leading to an exact solution is outlined. General expressions are found for the rates of change of invariant quantities which are the constants of energy and angular momentum in the Kepler problem, and formulæ are developed for the principal parts of these expressions in the case where the ratio of the masses of the two particles is small. This is applied in detail to the case where the orbit of the light particle is approximately circular. It is found that energy disappears from the motion, so that the orbital particle slowly spirals in, but the rate at which this occurs is much less than that given by the usual formula for radiation from an accelerated electron. Except in some final calculations no assumption of small velocity is made, the sole basis of approximation being the smallness of the mass ratio. AUTHOR.

*See also* Abstracts 169, 223.

## PHOTO-ELECTRICITY.

**291. Study of composite photocathode by electron diffraction.** R. UYEDA, S. ASAO, Y. SAYAMA AND A. KOBAYASHI. *Proc. Phys.-Math. Soc. Japan*, **22,** *pp.* 781–783, *Sept.*, 1940.—A photocathode was produced by oxidation of a silver film (obtained by vaporization from a tungsten coil) and subsequent introduction of Cs into the chamber. With only a small amount of Cs no photo-electric current could be observed, and the electron diffraction pattern consisted of sharp rings, possibly due to some oxides of Cs. With more Cs present the diffraction pattern became diffuse and a photo-electric current was observed, though this was small in comparison with that given by commercial tubes. The sensitivity was found to decrease again and at a later stage no photo-electric current could be observed. In this case the diffraction pattern again consisted of sharp rings, just as for the initial small amount of Cs. A. W.